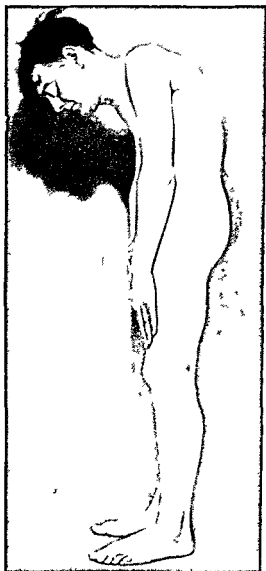


## ANKYLOSING SPONDYLITIS

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Severe stage III spondylitis in young man who but a few years ago was a distinguished athlete

*(Front aspect)*

# ANKYLOSING SPONDYLITIS



*A PRACTICAL GUIDE TO ITS  
DIAGNOSIS AND TREATMENT*

PART I

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## PREFACE

MOST AUTHORS of medical works find it necessary to apologize 'for adding one more book to the many existing on this subject', whatever it may be. We are not in this position. A search through the card indices of the Royal Society of Medicine library reveals only one volume on spondylitis—that by Dr S. Gilbert Scott. This monograph was published in 1942 by the Oxford University Press, and the author is, unfortunately, no longer with us. The book, though short, emphasized three things of vast importance: (1) that the earliest symptoms of spondylitis are not necessarily referred to the spine; (2) that changes in the sacro iliac joints occur years before any crippling occurs, and (3) that x ray treatment applied in the early stages of the disease will in most cases avert any serious consequences. These fundamental facts are now generally accepted, and are beginning to find a place in students' text books. Nevertheless, it will be a long time before all cases are diagnosed early enough to prevent deformity, and still longer before efficient treatment is available for all who need it.

Our aim in writing this book is both simple and ambitious. It is simple because we make no claim to add to existing knowledge as to the aetiology of the disease, or to add to Scott's diagnostic criteria. It is ambitious because we hope to present a practical guide, not lacking in details, to the treatment of the disease in *all* its stages. We hope to show that the attitude of extreme pessimism which has hitherto characterized medical writings on this subject is quite unjustified, and to prove that the therapeutic approach to these cases should be one of hope and confidence.

The means exist to forestall crippling in most cases. Unfortunately, despite this, it is all too certain that for decades to come spondylitic wrecks with kyphotic spines and ankylosed hips will continue to be seen in our patient departments. Owing to the work of Smith Petersen it is now possible to restore many of these patients to active life.

The book falls naturally into two parts, one dealing with the recognition of the disease and its treatment by all means short of surgery. For this, one of us (F. H. J.) a physician with a special knowledge of radiology, is responsible. The other (A. L.) an orthopaedic surgeon with a particular interest in spondylitis, has written of those recent surgical procedures which bring new hope

## PREFACE

to the hitherto "hopeless cases" But this work is not a mere binding together of two separate books under a single cover The authors have worked for some time in close co-operation, and each assumes general responsibility for the statements made by the other This responsibility does not, of course, apply to details, but only to broad results

The nature of the experience, medical, radiological and surgical, on which we base our views and recommendations, is set forth in our respective introductions to the first and second parts of this book

F H-J  
A L

*London, W*  
*September, 1949*

## ACKNOWLEDGMENTS

We wish to express our thanks for permission to reproduce illustrations to the Charterhouse Rheumatism Clinic for Figs 2, 3 and 7, and to Messrs E & A Livingstone for Fig 1

# ANKYLOSING SPONDYLITIS

## PART I





## INTRODUCTION

THE LATE Dr Gilbert Scott began his investigation of spondylitis about the year 1930, and it was my privilege to become closely associated with him at this time

At the request of the Oxford University Press I had written a book entitled *Radiotherapy in relation to General Medicine*. In this I advocated the use of x-rays in small repeated doses over a wide field in order to raise general body resistance in cases of metastatic breast cancer, this book was published in 1926. Subsequently I published papers in the *Practitioner* and elsewhere dealing with the x-ray treatment of certain rheumatic conditions. Scott was interested in the uses of "wide-field" x-ray therapy and, specifically, in the treatment of rheumatism—a subject to which, at that time, few radiologists paid much attention. He suggested that I should join him, which I did, and this association continued until the outbreak of World War II.

Although Scott and I shared a belief in the value of using x-rays for their constitutional effect, the idea of using them as a treatment for spondylitis was entirely his. It did not take me long to become almost as interested as he was, and I introduced the treatment into the hospitals with which I was then connected. During a period of nearly a decade I saw all of Scott's private cases and also many of those he was treating at the British Red Cross Society's Clinic for Rheumatism and at the Charterhouse Rheumatism Clinic.

For the first two and a half years of the war I was engaged in other matters. Meanwhile, Scott had been taken from us, and his assistant at the Charterhouse Rheumatism Clinic had been "called up". The care of patients with spondylitis devolved upon a refugee physician, who did not pretend to any special knowledge of radiology. Thus, by a kind of accident, an actual "spondylitic unit" came into being. For the first time one person was responsible for the care of spondylitics, no matter what treatment they required. Dr Warren Crowe (1939) had shown that many patients responded well to vaccines, and small doses of gold were known to be of value in some cases. So when, early in 1943, I was asked to take over the work (the foreign doctor having departed to America) I found it necessary to acquaint myself with forms of treatment other than that by wide field x-rays.

I found that I was dealing with 50 or 60 attendances per week, this went on during the remaining years of the war, and for some time afterwards, until the return of Dr Seth-Smith. Since then, we have shared the work between us.

Most of the patients I saw had already received x-ray treatment. The majority had benefited at the time, but had relapsed, while a few had not responded. At first I was inclined to think that the trouble lay in a lack of skilled supervision of the wide-field technique. The dosage had tended to become routine, whereas it requires adaptation to the individual patient.

Some improvement in results followed an overhaul of technique, but it soon became evident to me that a considerable proportion of patients required alternative methods of treatment if they were to be kept reasonably free from pain and able to do their work. The results, in general, were not so lasting as I had been accustomed to see. This was, I believe, due to the fact that the patients as a whole came from a less well-to-do section of the community, and that the anxieties and stress of war had lowered their resistance.

However that may be, I claim that there are distinct advantages in grouping patients with spondylitis under the care of one man. In the past they have suffered from a feeling of "nobody cares."

The patient with spondylitis has, indeed, been a kind of medical outcast. Consider the respective cases of a young man suffering from incipient tuberculosis, and one in the early stages of spondylitis. In the former case, all the resources of the State are put into action on his behalf. In the latter, he is left to shift for himself. No doubt there are several reasons for this, but a reason is not necessarily a justification. In the first place, the patient with spondylitis is not, like the tuberculous subject, a menace to his fellows. This no doubt accounts for the apathy of public authorities. As to the medical profession, there is an idea abroad that "rest is bad for spondylitics—so let them work!" A half-truth is worse than a lie. If by "rest" we mean immobilization in plaster as for tuberculosis, then "rest" is indeed fraught with tragic consequences. But "rest", in the sense of complete relaxation for long periods, with careful passive movements, faradic stimulation of muscles and so forth, is often desirable and not seldom essential.

Short of this, the patient with spondylitis needs an easy job and plenty of holidays. It is true that some patients hold down strenuous posts. I know one who is a shipwright and works full time in all weathers, and another who, as a customs officer, has to board swaying ships by means of a rope ladder. But these are exceptions,

## INTRODUCTION

in too many cases a man with 75 per cent or even only 50 per cent normal working capacity is attempting to carry on a job suitable only for a perfectly fit man

Another reason for neglect is that, in comparison with the numbers suffering from tuberculosis, the tale of the patients with spondylitis is relatively small. But if absolute numbers are considered, the total is impressive. The Charterhouse Rheumatism Clinic alone has nearly a thousand cases on its books, in Great Britain as a whole there must be tens of thousands. But they are a feeble folk, for the most part young, without influence, and lacking in this world's goods. They are also, as a whole, remarkably cheerful and uncomplaining, and not at all the sort of people to make a noise on their own behalf.

So long as he lived, Gilbert Scott was their champion—writing, lecturing, demonstrating cases, and raising money for research. Some of his optimism—though not much—has proved to be unjustified, and although the idea of x ray treatment has been finally “sold” to the medical profession, it has not been marketed in a form he would have liked. “Wide-field”, despite its virtues, has made little progress, whereas deep x-ray therapy—anathema to him so far as spondylitis was concerned—has become a recognized treatment. That good results can be obtained with deep x-rays can no longer be doubted. Scott's mind was always open to the logic of facts, if he were alive today, I can imagine his saying, “If you can cure them with deep x-rays, good luck to you.”

Well, he is not alive, and it is the duty of others to carry forward the work he started

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This section may perhaps be easier to follow if the general plan is here stated

I shall begin by trying to define what we mean by the term ankylosing spondylitis. This is not easy, because the name connotes merely a syndrome. Having done this, I shall proceed on *orthodox lines to give an account of its aetiology and pathology*; this account is bound to be unsatisfactory, as so little is known. Next are considered the diagnostic criteria, clinical and radiological. Then, before dealing with treatment, comes a chapter on some general principles, the object of which is to show that apparently diverse remedies may have a common action. After this, the use of x rays, of vaccines, of gold and bismuth, and of radioactive thorium X are dealt with separately in a series of

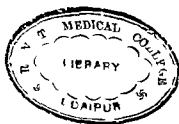
## ANKYLOSING SPONDYLITIS—PART I

chapters. Next, an attempt is made to integrate these remedies, to show how they may best be alternated or combined in an individual case. And, finally, the prognosis is discussed in relation to treatment.

• • •

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## CHAPTER 1

### THE SPONDYLITIC SYNDROME

THE TERM "spondylitis" means, simply, inflammation of the spine. But the intention of the authors of this book is not to deal with all forms of spinal inflammation. The nomenclature of diseases can be really satisfactory only in cases where the essential cause is known. This cause need not be the only one. For instance, the tubercle bacillus is only one of the causes of phthisis; the "soil" is equally important, and external conditions count for a good deal. But though it is true that there can be tubercle bacilli present without phthisis, there can be no phthisis without tubercle bacilli. There is little clinical similarity between, say, lupus and meningitis, or between these "diseases" and spinal caries. Yet the discovery that the tubercle bacillus is present in all of them enables us to name them as "tuberculous disease." The finding of a specific organism which satisfies the criteria of Koch is therefore a solid basis for classification.

Then there are the deficiency diseases. Their names were mostly given to them before their causes were known. But this is now of little consequence. Every medical student knows that myxoedema is due to lack of thyroid secretion, that rickets, scurvy and beriberi are caused by the absence of necessary vitamins. In the above instances and others of a similar type, clearing up the aetiology has resulted in successful treatment.

Diseases caused by living organisms, and those due to deficiency, whether of external supplies or of internal secretions, are easy to write about, because everyone has a clear picture of what the author refers to. All other so-called diseases are merely concepts derived from a consideration of syndromes. A syndrome is a group of signs and symptoms sufficiently characteristic, when found in a series of patients, to warrant the setting up of a "clinical entity." In former days, symptoms and physical signs were the sole means by which a "disease" could be recognized. Today we add x ray examination and chemical tests, such as that for the percentage of uric acid in the blood, also microscopic examination of the blood and tissues. All these modern investigations tend to make our concepts more definite. Nevertheless,

they remain "syndromes" not differing in essentials from diseases as conceived by our forefathers

The weakness of a system of classification based on syndromes is that although the human economy is subject to countless insults, both from without and from within, the number of symptoms by which outraged Nature can express herself are remarkably few. They include pain, fever, flux, swelling, spasm, incoordination, paresis, paralysis, disturbances of sensation, alteration in pulse and respiration, alteration in skin texture, in facial expression, and in the appearance of the urine. These were about all the symptoms the older physicians had with which to form their diagnoses. Except, of course, naked eye findings in the post mortem room. Scarlet fever and shaking palsy are both short clinical descriptions. Today we can do a little better. We place scarlet fever among the streptococcal diseases, but is "paralysis agitans" any better than shaking palsy?

One has only to look at tables of differential diagnosis to see how the same symptoms recur and how difficult it is to make clear-cut distinctions, and, at the bed side, "difficult" may become "impossible". The trouble with symptom complexes is that there are just not enough symptoms to go round.

Nevertheless, in the present state of our knowledge, we must, for practical reasons, continue to call syndromes "diseases". A diagnosis of disseminated sclerosis is valuable for prognostic reasons, though it helps us little in treatment. Malaria a hundred years ago was no more than a syndrome, yet the recognition of this syndrome carried with it the duty of giving the patient quinine. From this example it is evident that the finding of a remedy for a disease need not necessarily await the scientific elucidation of its cause.

## 1. TYPICAL SYNDROME OF SPONDYLITIS

All the above is preliminary to the confession that the disease we propose to write about is, so far, no more than a syndrome. Consider the hypothetical, and hence entirely typical, case of A B.

### Pre-spondylitic stage

A B is an athletic young man of 19 years, distinguished at tennis, hockey and swimming. He consults his doctor because of pains down the front and outside of his thighs. In reply to questions he states that from time to time he has had vague pains in various parts of the body, but they have been transient. The

doctor murmurs something about "a rheumatic tendency", gives him a salicylic mixture, and forgets all about him. And the young man forgets about his doctor because his pains disappear and he is able to resume all his activities.

But six months later the pains recur, with greater severity. This time the doctor examines him thoroughly. All his movements are good, and his back is supple. The only thing of note is that when the patient is lying on his face he does not like manual pressure on his lower dorsal vertebrae.

The doctor sends him to a radiologist, who reports that his spine appears normal but that both sacro iliac joints show signs of inflammation. What the radiologist really sees is a widening and irregularity of the joint space, due to decalcification of the surrounding bone. The report adds that, in view of the history, the case should be looked upon provisionally as one of ankylosing spondylitis.

This does not mean that ankylosis is present. Far from it. This is the stage of decalcification and softening. The name indicates, in convenient shorthand, what will happen if the malady is unchecked.

#### Stage of commencing spinal symptoms

The patient is advised to have x-ray treatment, but there is no centre near at hand and it would be very inconvenient to have to go far afield. He puts the matter off, and after a time his leg pains bother him less. A year later, however, he is somewhat disturbed to find that as his legs improve he begins to get pains in the back and to notice that his spine is less flexible. He is again x-rayed and this time there is no doubt about it. There is a deposition of calcium in the spinal ligaments in the lumbar region, and the dorsal vertebrae appear somewhat osteoporotic. The sacro iliac joints show increased decalcification in some places and commencing sclerosis in others.

#### Stage of progressive crippling

A B is now really frightened, especially as he is aware that he is becoming increasingly flat-chested and is losing weight. At this moment there comes an opportunity to secure a very lucrative appointment in Egypt. His friends are convinced that he has tuberculosis, "no matter what the doctors say". They think a warm, dry climate will be just the thing for him. He is only too willing to be persuaded, and away he goes to live in remote places for the next 5 years.

He is very busy, and scarcely has time to note what is happening to him. But he is conscious of an increasing stoop, a diminishing capacity for hard physical exertion. He has pain, but it is not, as a rule, unbearable. Sometimes he has to lie up for a few days, and once he was off duty for a month. Still, he carries on somehow, by sheer force of will, holding down a job suitable only for a fit man. But there comes a day when he cannot walk because of a severe pain in the groin. The acute phase passes off, but he now finds that to his stoop is superadded a forward flexion of his whole body. He cannot balance without a stick, if he did not use one he feels he might fall on his face. He gives in and comes home.

A B visits his doctor, who is appalled at the change in him, a change which, fortunately, the patient himself does not fully realize. By this time he is using two sticks, and can see ahead only by extreme turning up of his eyeballs. One hip is immovable, the other nearly so, and he walks, or rather shuffles, by the aid of his knee joints only. Radiographic examination shows complete sclerosis of the sacro-iliac joints and complete ossification of the spinous ligaments in the lumbar region—"bamboo spine". The intervals between the vertebrae are not narrowed. The hip joints show complete loss of articular cartilage, but no osteophytes. To crown his misfortunes, A B develops a severe attack of iritis.

## 2 ANALYSIS

Following Scott (1942) and Forestier we may divide the progress of A B's case into three stages.

### *Stage I The pre-spondylitic stage*

This was definitely established when the first radiological examination was made. At this time there were no spinal symptoms, only pain in the legs. The key to the meaning of these pains was the change in the sacro-iliac joints.

### *Stage II The stage of commencing spinal symptoms*

This phase was entered a year later. By then, the radiological picture had changed. The sacro-iliac joints showed a mixture of decalcification and sclerosis, and there was some calcification of spinal ligaments. But there was still no visible deformity.

### *Stage III Stage of progressive crippling*

During the next 5 years A B developed a rigid lumbar spine, severe dorsal kyphosis, and, finally, fibrous ankylosis of the hip joints.



*Additional stages*

To these three stages we may perhaps add two more, one in the past and one in the future. Stage I is termed "pre-spondylitic", which means that there are no spinal symptoms, but there are radiological changes in the sacro iliac joints. It may well be that there is a phase antecedent to this, which may be termed "prodromal", when pain is the *only* indication of what is happening. A B was not subjected to radiological examination when he first complained: perhaps at that time there would have been no radiological changes to see. This is not a mere speculation of purely theoretical interest. It is one to which I shall refer later when discussing preventive treatment.

There is also the dire possibility that A B may not remain in the third stage. There may be even worse things to come, such as a progressing kyphosis which results in the dorsal and cervical portions of the spine becoming parallel with the ground. The chest has long been rigid and now even diaphragmatic breathing is interfered with, digestion is impaired, and, added to all the above, the mandibular joints may become fixed making, as Buckley (1936) says, "such an appalling picture that death itself is welcomed".

Although at this moment I am not dealing with treatment, I hasten to point out that even when a patient is not seen until stage III is well established, this 'appalling picture' need never materialize. Modern medicine can stop further progress of the disease, and modern surgery can remobilize ankylosed hips, and even to a considerable extent correct the spinal deformity.

## 3 NOMENCLATURE

A B is, as I said, an imaginary case carefully built up to give a vivid and clear-cut picture of what we mean by spondylitis. This disease, a syndrome, has been known by a vast number of names with which I do not propose to burden the reader. Scott proposed the term *spondylitis adolescens*, because he believed it was essentially a disease of youth. At one time I thought this a good name, but I have since seen so many cases in which the onset occurred suddenly in the thirties or forties, and in which no history of warning pains could be elicited, that I now think the term is not clinically justified. Scott objected to the term *ankylosing spondylitis* because he said this was a late phase which need never be allowed to occur. This is largely true, but it does not alter the fact that a tendency to ankylosis is the prime characteristic of the

malady, if left to its natural course, also the use of the word *ankylosing* in the nomenclature serves as a continual warning of what must be avoided

There is only one other name which I shall mention, and that only to condemn it. It is the American term, "rheumatoid spondylitis." It is always a bad thing to commit oneself in a name to some particular pathological view which is not proved. This kind of "claim-jumping" should be discouraged. The aetiology of rheumatoid arthritis itself is obscure. It, too, is a syndrome rather than a disease, and I agree with Buckley that ankylosing spondylitis is not a form of rheumatoid arthritis, the name used in this book has the advantage of being purely descriptive.

#### 4 VARIATIONS IN THE SYNDROME

Although the case of A B has been artificially constructed, a considerable number of untreated cases resemble it very closely. But there are, of course, wide variations. Stage I may be symptomless, and the patient does not present himself until stiffness and pain in the spine occur. Again, the passage from stage II to stage III may occupy not 5 years but 20 years, and there may be long periods of intermission, lasting in some instances for 12 months or more. Recently I saw an officer of the Indian Army, aged 45 years, who had his first spinal symptoms at the age of 22 years. He went through more than one campaign, and was never off duty for more than a month, and that only on three occasions. He was not, however, regarded by his superiors as a fully fit man, and his promotion suffered. He had had no treatment of any kind, yet when he came to me he was not strikingly deformed: he merely stooped and was somewhat stiff in his movements. Radiologically, he was definitely in stage III, with ankylosed sacro-iliac joints, "bamboo spine" in the lumbar region, and with dorsal kyphosis. There was no ankylosis of the hips or of other joints.

#### Implication of the hands

Occasionally, shoulders and elbows are affected. Indeed it is said that any joint in the body may be attacked. But involvement of fingers and wrists is so rare that it should not be too hastily assumed to be due to spondylitis, even in well-established cases of this disease. In all the many hundreds of cases I have seen in the past 18 years, only once have I seen the hands implicated. A young man of 22 years, who had spinal symptoms and extensive sacro-iliac involvement, responded well to wide field x-ray treat-

## THE SPONDYLITIC SYNDROME

ment A year later he attended with swollen wrists and fingers, but no complaint of spinal pain He gave a history of sore throat, and an examination showed enlarged and unhealthy-looking tonsils These were removed and within a few weeks his hands and wrists recovered Since that time he has had some relapses of spinal pain, but no further trouble elsewhere

I do not believe the lesions in his hands had anything to do with his spondylitis a patient with spondylitis is as likely as anyone else to have a septic throat or other source of focal sepsis, and to develop "rheumatic" symptoms accordingly The moral of this case is that, even if we believe that focal sepsis in teeth, tonsils and elsewhere has no causal connexion with spondylitis, it is nevertheless essential to look out for such foci

### "Poker back"

An expression often found in the literature is 'poker back' This suggests a ramrod like uprightness but the term is often misused to denote the ankylosed spine resulting from spondylitis, irrespective of its shape The condition does, however, exist On one occasion when examining some radiographs of a chest I saw that the whole spine appeared solid I sent for the patient and was confronted by a healthy-looking middle-aged man who held himself like a drill-sergeant I asked him to pick something off the floor, which he did smartly by squatting, his back never moved He was quite unaware that there was anything the matter with his back, and, as he had no pain, I did not enlighten him One can only suppose that in such cases there is a high natural resistance, and that calcification appears before sufficient osteoporosis has occurred to allow the spine to bend

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## CHAPTER 2

### AETIOLOGY AND PATHOLOGY

#### 1. AETIOLOGY

NOTHING is really known about the causation of spondylitis. All attempts to find a specific organism have failed, nor is there any evidence to suggest that it is a deficiency disease. There is no uniform chemical change in the blood such as occurs in gout, in which the increase of uric acid, while apparently not the cause of the condition, is at least a constant feature and serves to identify the disease.

#### Sex incidence

Although characteristic changes in the blood have not been found, it has recently been stated by Davison, Koets and Kuzell (1949) that in spondylitic patients the excretion in the urine of the 17-ketosteroids (end-products of steroids originating in the adrenal cortex in the female, and the adrenal cortex and the gonads in the male) is about twice as much as in healthy males, in rheumatoid arthritis the excretion of these products was only slightly raised. If this work is confirmed, it will at least give us further diagnostic criteria, and may cast some light on the sex incidence of spondylitis.

Kennedy found, from his analysis of 115 cases, that in those diagnosed as "pre-spondylitic" the ratio of males to females was 2 to 1, but in cases with spinal symptoms it was 7 to 1, and he asks whether sacro-iliitis has the same significance in the female as in the male. If, however, it can be shown that spondylitis is associated with disturbances of the biochemistry of the sex glands, we could well understand that resistance to the disease might be greater in the female than in the male, and that, consequently, a higher proportion of cases is aborted before the development of spinal symptoms.

#### Infections as causative factors

##### *Is spondylitis an infection?*

Clinically, spondylitis has many of the features of an infection especially in cases which are subject to acute exacerbations. Some rise of temperature and a raised blood sedimentation rate are

suggestive of, but not pathognomonic of, microbial invasion. They may occur, for example, in gout.

Scott's view was that an infection occurred in the sacro-iliac joints and that the "wandering pains" were due to "focal sepsis"—just as a patient may have general rheumatic pains as a result of septic tonsils. But he admitted that he had been unable to find any direct evidence for this theory.

A clinical picture very similar to the cryptogenetic spondylitis with which this book deals can certainly be produced by known infections. The *Brucella* group (*B. abortus*, *B. bronchiseptica*, *B. melitensis*) is said to produce an ankylosing spondylitis. Goldfain (1943) records 18 cases.

French writers lay stress on gonorrhoea as a frequent cause. As spondylitis is most common in young, previously healthy, males, it is not surprising that a history of Neisserian infection can often be obtained. Even so, the number of such cases is relatively small in Great Britain, and the matter is of little importance unless the infection can be shown to be still active. Even then, the cure of the condition should not be looked upon as the removal of an aetiological factor, but rather as removing something which militates against the action of remedies directed to the arrest of the spondylitis.

### *Tuberculosis*

Robinson (1940) states that he tested for sensitivity to tuberculosis 45 patients suffering from ankylosing spondylitis and concluded that, in comparison with 90 patients afflicted with ordinary rheumatic conditions, the former group showed a 30 per cent higher degree of sensitivity. This observation seemed to me a very important one, and one worth following up.

If the sacro-iliac joints are indeed infected, the infection must be of a very low grade virulence, as not only is no pain complained of in this region in stage I, but no tenderness can be elicited.

### **Spondylitis in relation to disorders of calcium metabolism**

Whatever the cause, cause of the syndrome known as spondylitis, the immediate trouble is a disturbance of calcium metabolism. Let us consider briefly some of the other syndromes in which this is a prominent feature.

There may be an excess or a deficiency of calcium in various tissues, often the processes of undue absorption and undue deposition go on simultaneously.

*Myositis ossificans progressiva*

In this disease tender swellings occur in the muscles, and then develop into hard fibrous nodules which are ultimately converted into bone. The condition usually commences in childhood and progresses slowly to a fatal issue. The course of the disease is marked by exacerbations and remissions. The body may be enclosed finally in a sheath of bone which makes all movement impossible. Most text-books do not even speculate as to its cause, but certain resemblances to spondylitis should be noted.

*Marble bone*

This, like progressive myositis ossificans, is fortunately a rare malady. It also begins in childhood, and is characterized by excessive calcification of bone, but little true ossification. Experimental work suggests that a sustained condition of mild hyperthyroidism may be one of the underlying factors. Selye (1947) found that when small doses of parathyroid extract are given to an experimental animal over long periods of time, there is increased bone formation owing to stimulation of osteoblasts. The bones assumed the same extremely dense character which is seen in marble bone.

*Hypervitaminosis*

To the above instance of increased calcification may be added hypervitaminosis due to vitamin D. If this vitamin is given in great excess, and the diet is rich in calcium, calcareous deposits occur in many of the tissues, notably in the renal tubules and the walls of the arteries.

**Diseases characterized by lack of calcification***Rickets*

In the rickets of childhood the chief causative factor is undoubtedly lack of vitamin D. The bones become soft and, if the condition is untreated, permanent deformities such as 'bandy legs' or the 'rickety rosary' may occur, yet in most cases the bones of the legs, though permanently bent, ultimately become thicker and stronger than the average. Parathyroid hyperplasia may occur, but it is secondary and compensatory.

*Late rickets*

This condition is commonly said to be of similar origin to the ordinary rickets of childhood, namely deficiency of vitamin D.

It is doubtful whether this is the case. It seems to be confined to the female and may begin at the age of puberty, without any change of diet or conditions. The softening of bone may reach an extreme degree. The disease is rare and few opportunities for study occur in Great Britain, but it seems to be associated with sex development rather than with vitamin deficiency.

### *Osteitis fibrosa*

In osteitis fibrosa the blood contains an excess of calcium and a diminished amount of phosphorus, there is a raised concentration of blood phosphatase. Calcium is excreted in the urine in excess. Skiagrams show multiple cysts and marked decalcification of the skeleton.

The immediate cause is excessive secretion of parathormone, due to the presence of a parathyroid adenoma. Removal of the adenoma leads to arrest of the disease, and even to some degree of recovery of bone structure.

Complete removal of the parathyroid gland results in a hypocalcaemia which causes extreme neuromuscular excitability. Deficient parathyroid secretion causes the same phenomenon in varying degree. It is worth noting that Scott (1942) demonstrated the existence of muscular irritability in many cases of spondylitis.

### *Rheumatoid arthritis*

To the diseases in which decalcification is a prominent feature should be added rheumatoid arthritis. Here the osteoporosis is general, whereas in spondylitis it is local. Parr and Shipton (1946) state that they have checked the serum calcium content in a large number of cases, and that they found no great variation from normal.

### **The parathyroid glands and spondylitis**

The elucidation of the role of the parathyroid glands in calcium metabolism some years ago raised a hope that here was a key to the spondylitic lock. Although the later stages of spondylitis are characterized by excessive localized calcification, it should not be forgotten that the earlier radiographic picture is one of decalcification. In fact, some authorities claim that the earliest radiographic sign is not sacro-iliac involvement but osteoporosis of the pelvis and of the lumbar spine (Buckley, 1938). The parathyroid glands are often enlarged, hence it was argued that their removal might arrest the disease. Russian surgeons, and later,

American surgeons, began to operate on spondylitic cases. At first, many successes were claimed, but we hear nothing about the matter now. In view of the fact that no one has yet shown the existence of any significant changes in the blood, such as occur in osteitis fibrosa, the failure of the operation is perhaps not surprising.

### Future possibilities

The foregoing remarks are intended to show that the aetiology of ankylosing spondylitis is not an isolated problem. Obscure as it is, it is not more obscure than was that of rickets 30 years ago, or that of osteitis fibrosa till a much more recent date. At any moment the real key may be discovered. An aberrant form of tuberculosis, a ductless-gland disturbance, or some failure in vitamin production or utilization are at present the likeliest guesses. (Recent work at the Mayo Clinic has shown that the administration of a certain adrenal hormone has a remarkably beneficial effect on rheumatoid arthritis—so long as it is exhibited. In this connexion should be noted the observation of Davison and his colleagues (1949) to the effect that excessive excretion of the 17-ketosteroids in spondylitis continues during periods of remissions. Also to be noted is West's evidence in favour of the familial incidence of spondylitis.) But although, lacking a knowledge of aetiology, we are denied the sense of artistic completeness in our treatment which comes, say, with the exhibition of vitamin D in rickets, or the removal of a parathyroid adenoma in osteitis fibrosa, we are not denied the satisfaction, as clinicians, of enabling most of the victims of spondylitis to live normal lives.

## 2. PATHOLOGY

Various attempts have been made to isolate an infective organism from the sacro-iliac joints. No success has so far attended these efforts.

In Scott's book on spondylitis (Scott, 1942) there is an account by Frupp of investigations carried out at Scott's suggestions. The methods employed involved the laying bare of a sacro-iliac joint, followed by drilling, and the use of suction through an aspiration needle.

The procedure proved difficult in practice, and only staphylococci were cultivated from the material obtained. The presence of these was almost certainly due to contamination.

One negative result of interest was obtained, however. Animals inoculated with the material showed no sign of tuberculosis.



## AETIOLOGY AND PATHOLOGY

Recently, at the London Hospital, abundant material has been available from spondylitic hips, the patients being, of course, in the later stages of the disease. The results of careful examination for microbic infection of the scrapings removed in the course of operation proved to be negative.

It may also be noted that no pathological organisms have ever been found in spondylitic iritis.

### 3 MORBID ANATOMY

Post-mortem observations are rare, as the disease is not fatal in itself. When death occurs it is an indirect result, due to oxygen starvation caused by a rigid thorax and a kyphosis so pronounced as to interfere with diaphragmatic breathing. In short, these patients usually die in the hands of some medical man not specially interested in spondylitis. Add to this the very common objection to post-mortem examinations evinced by relations, and it is small wonder that opportunities are few.

Freund (1942) states that a pannus formed from the synovial membrane causes the absorption of articular cartilage, which is replaced by fibrous tissue.

He found changes in the apophyseal joints, but no involvement of the cord or of the intervertebral foramen.

Freund had no opportunity of examining unankylosed sacro-iliac joints, and there appears to be nothing written about their pathology, apart from what is deducible from radiographs. Frupp, however, does mention that his drill, after passing through hard cancellous bone, passed into a cavity consisting of a soft meshwork of bony trabeculae.

There are records of post mortem examinations in which the affected spinal vertebrae were so soft that they could be cut with a knife.

Stockman (1940) held that spondylitis starts as a periarticular fibrositis. It is, at any rate, a clinical fact that severe pain and very considerable spinal deformity may exist without radiographic changes in the vertebral column. It is in such cases that dramatic improvement in posture may be obtained by deep x-rays concentrated on the kyphotic area, or by manipulations. X rays have a well recognized lytic effect on pathological fibrous tissue: the best results are likely to be obtained by a combination of, or rather, a sequence of, the two methods.

### Ankylosis

The ankylosis which occurs in spondylitis may reach a form

more complete than that in any other disease with which I am acquainted. This is especially noticeable in the hips. I have seen radiographs which showed not the smallest trace of any joints. The appearance was that of thigh bones integral with the pelvis so perfectly were the trabeculae rearranged that anyone not cognizant of spondylitis and its capabilities would have been quite justified in thinking that he was looking at a case of congenital absence of the hip joints.

To sum up, the post mortem room has so far added little to our knowledge of spondylitis; what we know of its pathology is mostly the result of radiographic investigation.

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## CHAPTER 3

### CLINICAL DIAGNOSIS

IN NINETY-NINE cases out of a hundred the patient is first seen in the private consulting room or in the medical out-patient department of a hospital. Very occasionally, however, spondylitis first shows itself by an acute attack of generalized pain, accompanied by some rise of temperature. The patient is confined to bed, and sends for his family doctor. The physician may think that his patient is threatened with rheumatic fever and such an attack has been known to mimic an abdominal emergency. In fact the trouble usually passes off in 2 or 3 weeks. Later, while the patient is ambulant, definite signs of spondylitis appear. As spondylitis is rare, compared with other forms of rheumatism, and as it is very unusual for it to have an acute onset—although acute phases in the established disease are fairly common—the doctor can scarcely be blamed if he does not even think of spondylitis. Nevertheless, in any unexplained attack of this kind especially in a young person, the possibility of spondylitis should be borne in mind, and the patient should have his sacro-iliac joints examined radiologically. If nothing untoward is found he should still be kept under observation.

Ambulant patients when first seen fall into three groups, corresponding with the three stages described in Chapter 1.

#### 1. PAIN IN REGIONS OTHER THAN THE SPINE

The first group is composed of those who complain of pain in regions other than the spine. Vague pain in the lower limbs is the most usual complaint, and is often labelled sciatica. Or the pains may occur in the thorax, and be put down to intercostal myalgia. "Girdle pain" may be described. Unless the patient is suffering from the fortunately very rare type of fulminating spondylitis, which runs its whole terrible course in a year or two, the pains go off, and are forgotten.

If all such persons subsequently developed ankylosing spondylitis, no doubt there would soon be a great pothor, and preventive measures would be taken. But quite often these people are indeed suffering from nothing more serious than muscular rheumatism.

Also, there can be little doubt that Nature may abort early spondylitis just as she often does early tuberculosis. The net result is that only a small percentage of such patients ever develop a frank spondylitis, and, as this may not happen till years later, very often they are not seen by the man through whose hands they originally passed. Hence the possible significance of these early symptoms is only very gradually becoming appreciated by clinicians.

There is no purely clinical method of weeding out potential cases of spondylitis. The only safeguard is to send every young man and young woman who complains of "rheumatic pains" for which there exists no adequate explanation, such as a history of rheumatic fever or a septic throat, for radiographic examination of the sacro-iliac joints.

### Radiographic changes in the sacro-iliac joints

According to Forestier (1939), the disease does not begin in the sacro-iliac joints, but in the apophyseal joints. The radiographic findings in the latter are, however, extremely difficult to interpret, and Forestier admits that, for practical purposes, radiographic changes in the sacro-iliac joints are of prime importance. Radiologists are becoming increasingly competent to detect and interpret these changes, which Scott called "sacro-ilitis" (This term is convenient and widely used. But we must not let it commit us wholly to a theory not yet proven.)

Some have thought that Scott allowed his enthusiasm to run away with him. Kennedy conducted an independent investigation at the Charterhouse Rheumatism Clinic of 115 cases. His conclusions were as follows:

"Bilateral infection of the sacro-iliac joints is an early and constant sign in ankylosing spondylitis. Although many cases of bilateral sacro-ilitis as demonstrated by x-rays proceed to spondylitis, sufficient inconsistencies are present to make it an unwarrantable assumption that every case of bilateral infection is, *ipso facto*, an early spondylitic."

The first of these conclusions is the important one. There can be no spondylitis without sacro-ilitis. Like so many dicta in medicine, this conclusion is not absolute. Very occasionally, there are cases which are clinically early second-stage spondylitis, that is, they have definite spinal symptoms, but in which there are no changes in the sacro-iliac joints. I myself have seen two such patients, but, unfortunately, do not know their after-history. Parr and Shipton (1946), however, say they had two cases of this

type in which, 4 years later, definite radiological changes became apparent

In regard to the opposite exception, sacro-iliitis without subsequent spondylitis, this really does not admit of proof, one way or the other. In the first place, Nature may effect a cure secondly, the disease is capable of lying latent for such lengthy periods that decades of observation would be required to reach certainty

The matter is, in any case, of theoretical interest only. Whether or not a few cases with pre spondylitic symptoms and infection of sacro-iliac joints will in fact escape spinal lesions cannot in any way affect the duty of the physician, which is to initiate treatment known to be effective. And even if no changes in the sacro-iliac joints are found, if the pain resists ordinary physiotherapeutic methods, mild x ray treatment can do no harm and may give relief

## 2 SPINAL PAIN WITHOUT PATENT DEFORMITY

The second group of patients present symptoms which should at once raise suspicion of spondylitis. They show either no obvious deformity or merely round shoulders and a stoop, an appearance which is unfortunately too common to be characteristic. The symptoms complained of are definitely spinal and there may or may not be a history of pains elsewhere which have vanished when the patient is seen by the physician. Pressure over the lower dorsal region with the patient in the prone position is resented. He may complain of sharp pain in this region when he coughs or sneezes, or when he jars himself in stepping off a pavement. "Girdle pain" is often complained of, it should in any case be inquired about. The sacro iliac joints are not tender. The patient may feel well, and may be able to carry on his ordinary duties but if he is an athlete, as he often is, he will have given up all or most of his sporting activities.

The above picture in a young patient, say, under 30 years of age, would justify the physician in making a clinical diagnosis of ankylosing spondylitis, although he would have to bear in mind the possibility of tuberculosis. But if, for some reason it was not possible to obtain a radiographic examination his duty would be to treat the case, at least tentatively, as one of spondylitis.

Fortunately in these days such a situation seldom arises, and the patient would normally be sent to the x-ray diagnostic department. It is the business of the radiologist to help to exclude tuberculosis and certain other diseases of bone. If he sends back

a report of extensive sacro-iliac decalcification, with here and there commencing sclerotic changes, and of commencing calcification of spinal ligaments, the diagnosis of ankylosing spondylitis is firmly established

### 3 OBVIOUS DEFORMITIES

The third group scarcely needs description. It includes patients whose deformity is obvious, such as kyphosis, torticollis, or ankylosis of the hips. In young people such a picture means ankylosing spondylitis in a fully developed stage. Examination shows a rigid thoracic cage, with diaphragmatic breathing only, and in cases of extreme kyphosis even this may be becoming difficult. The disease may or may not be active. If it is, these patients require some treatment on the usual lines, but their only real hope is with the orthopaedic surgeon.

In intimating that the diagnosis could be made "at sight", I qualified my statement by the words 'in young people'. But true spondylitis may reveal itself for the first time in the middle aged, or even in the elderly. I have seen one case in which the first spinal symptoms occurred at the age of 60 years. In discussing diseases characterized by disorders of calcification, I should perhaps have added senility. We are all familiar with the changes which occur in too many people with advancing years. They develop a dorsal kyphosis, the head is thrust forward, the neck is stiff and the gait shuffling. The thorax loses its elasticity and its expansion is lessened. One of the saddest things about spondylitis is that in a few years it can produce in a once vigorous athlete just such a picture. If we see a man of 70 years so distorted, the chances are, of course, that he is not suffering from ankylosing spondylitis, but from spondylitis osteoarthritis. But *is* he 70 years old? Let us be sure of this before we dismiss him hurriedly to the physiotherapy department for some placebo. He may, in fact, be a patient with spondylitis aged 50 years or less and not altogether beyond our aid.

### 4 DIFFERENTIAL DIAGNOSIS

#### History-taking

It is of the greatest importance in examination of patients in the first group to elicit a possible story of recurrent attacks of non-spinal pain with symptom-free intervals. But history taking is scarcely less important in the second phase though for a different reason. The human mind is so constituted that a patient always

tries to find some explanation for any complaint from which he suffers. If he experienced any kind of accident to his back not too long before the onset of spinal symptoms, he will attribute them to it. By reason of dwelling on the injury, he will often, in perfectly good faith, exaggerate its severity. If the site of his injury coincides more or less with the area of spinal pain and tenderness, the physician, if he is not on his guard, may make a facile diagnosis of post-traumatic pain, and the true nature of the trouble may be missed.

On the other hand, the patient may not remember a severe injury which did not directly involve the spine. Yet it is a fact that any intense physical shock, or, for that matter, mental shock, may be an "exciting" cause, turning a latent case of spondylitis into an active one. This is important from a medico-legal point of view. Such a patient may not be receiving the compensation or pension to which he is entitled, and which would relieve financial anxiety detrimental to his recovery. Because radiological examinations in the case of injured Servicemen showed spondylitic signs which must have preceded the accident, these unfortunates were denied pensions in the early years of World War II, but I am glad to say that a more sensible and humane view later prevailed.

### Malignant disease

In young people the chance that spinal symptoms are due to malignant disease is small, but middle aged patients do attend who label themselves, or have been labelled by their medical attendants, as "rheumatic", but who are, in fact, suffering from primary or secondary neoplasms. In urging physicians to become "spondylitically minded" we may succeed too well, and in some instances produce a kind of conditioned diagnostic reflex in which back pain and spondylitis become indissolubly linked. "Have you got spondylitis? No? Well, if you visit so and-so, you soon will have!" This gibe, though mostly unjust, has enough truth in it to make it sting.

A wrong diagnosis when symptoms are in reality due to malignant disease brings discredit on all concerned. In the rush and bustle of an out-patient department such mistakes are bound to occur (nor is there less rush and bustle in the department of the radiologist). But at least the history-taking can include a question asking whether the patient has experienced any operations.

Even when the possibility of malignant disease is appreciated in an individual case, and special radiological examination is asked for, it is not always easy to be sure. As I said in an earlier

chapter there are not enough symptoms to go round and each type of disease may simulate another for long periods. In cases of doubt the safest line is to submit the patient to wide field x ray treatment. This may produce improvement in either case but intensive radiotherapy should be avoided as it may knock out the resistance of a patient suffering from metastasis and precipitate a fatal issue.

### Adolescent kyphosis

In Handfield Jones and Porritt's (1948) *Essentials of Modern Surgery* there is a photograph (Fig. 1) which would serve excellently to illustrate the deformity of ankylosing spondylitis. But it is in fact a picture of adolescent kyphosis.



FIG. 1—Adolescent kyphosis

This condition is most common in patients aged 12–18 years and is believed to be due to a vertebral epiphysitis analogous to that of juvenile osteochondritis. It may be merely postural. A very brief examination will determine this point. But it may also have become organic and permanently irreducible. The patient may complain of localized pain and of pain in the legs; there may be spinal tenderness when pressure is applied. In fact the condition may closely simulate spondylitis. Yet it is a totally different condition with a much less serious prognosis and requiring different treatment. In a young subject the appearances of the sacro iliac joints may be equivocal. Radiological examination may however show loss of the intervertebral spaces. This does not occur in ankylosing spondylitis. For a full discussion of this disease with illustrative radiographs the reader is referred to the paper by Brocker (1949).

### Tuberculosis

Spondylitis has often been confused with tuberculosis. Error may occur in the first or second stage.

#### *Misdiagnosis at the pre spondylitic stage*

Sacro iliac change may be misinterpreted as tuberculosis when it is really a sign of commencing ankylosing spondylitis. The



## CLINICAL DIAGNOSIS

patient may be put to bed for a long period, but the ill consequences are usually not very serious, because a certain amount of limb movement is still possible. Presently it is realized that the patient is slowly getting worse, and the diagnosis is revised.

Clinically, a patient who complains of pain referred to the sacro-iliac region, and who resents palpation in that quarter, is unlikely to be suffering from sacro ilitis of spondylitic origin. From a radiological point of view a bilateral sacro iliac lesion is unlikely to be tuberculous. The difficulty arises when only one side is affected. A patient complaining of sacro iliac pain and showing radiographically only one side affected should be provisionally treated as tuberculous. If there is a one sided lesion but no pain or tenderness it is safe to treat him for spondylitis, watching carefully his response. In many cases a later radiograph reveals that decalcification has commenced in the other joint also.

### *Misdiagnosis at the stage of commencing spinal symptoms*

Confusion is more likely to occur between tuberculosis and spondylitis in the earlier part of stage II. In the out patient room a cadaverous looking patient with dorsal kyphosis and a complaint of severe aching raises a suspicion of tuberculous caries. Although angular kyphosis is the more usual form in tuberculosis, if several bodies are affected there may be a curve resembling that in spondylitis, and it is in these cases that there is a difficulty in immediate diagnosis. Radiological examination of the spine will usually clear up the matter, but sometimes very little is seen. If the sacro-iliac joints are not examined, and a bilateral sacro ilitis is thereby missed, it may be decided to treat the case as one of tuberculosis, with unfortunate results.

### *Risk of causing ankylosis of the hips*

An even worse error is to mistake a commencing spondylitic lesion of the hip for tuberculous arthritis. If the general picture is already characteristic, with spinal deformity and other usual symptoms, the mistake should not occur, but in a few cases hip symptoms develop early and overshadow everything else in the patient's mind, and so, too often, in the mind of the doctor. A radiological examination is of course asked for, but probably only of the hips, with a clinical note, "tuberculosis." The radiologist may find nothing characteristic, but only, perhaps some osteoporosis in the neighbourhood of the joint, he sends back a non-committal report. Now, in a suspected case of tuberculosis, it is,

of course, good practice not to await radiographic confirmation, so the patient is put to bed and the hip is immobilized. The end in view, ankylosis, is attained only too successfully, and the patient leaves the hospital not only with one stiff hip, but probably with two!

The above paragraph deals with misdiagnosis. Occasionally in an acute exacerbation in spondylitis a hip may be so painful that immobilization for a short time is essential in order to give the patient ease.

This picture is no mere bogey to frighten children. It has occurred, is occurring, and will continue to occur until the dangers of mistaken diagnosis sink into the minds of the medical profession. "I walked into the hospital with one stick six months later I was carried out on a stretcher." Scott records cases of this kind, I have seen several.

The trouble is that the patient with a commencing spondylitic arthritis of the hip may show some of the classical early signs of tuberculosis. Thus definite flexion and adduction of the thigh and wasting of the buttock muscles may occur. What can be done about it? The clinician should remember to ask for radiography of the sacro-iliac joints. And the radiologist, disregarding ill-judged pleas for economy, should never be content, except perhaps in the case of elderly patients, with a small film just big enough to show one hip. He should, as a routine, include both hips and the pelvis on a film of sufficient size, and he should always look at the sacro-iliac joints.

### **Rheumatoid arthritis**

If I were confining myself to my own experience, I should not place rheumatoid arthritis among those diseases or clinical entities with which ankylosing spondylitis may be confused. But I include it for two reasons. (1) Some writers say that spondylitis may occasionally first attack the knees, or the joints of the fingers. (2) Certain American authorities claim that ankylosing spondylitis is but a variant of rheumatoid arthritis.

The aetiology of rheumatoid arthritis is scarcely less obscure than that of spondylitis, though the evidence for infection is perhaps stronger. We must admit that rheumatoid arthritis is merely a syndrome, but just what combination of signs and symptoms makes up the clinical entity? There is, unfortunately, no general agreement on this, except in a negative sense. Everybody agrees that rheumatoid arthritis is *not* the same thing

as osteoarthritis—or, as Boyd (1947) and others prefer to call it, osteoarthrosis, they say it should be so named because it is a degeneration and not due to infection. This is open to doubt, but the truth or otherwise of the “degenerative” view is not germane to our present subject. No one would accuse the otherwise healthy man who is crippled by rheumatic disease of one hip of being a victim of rheumatoid arthritis. But what about all the otherwise healthy women who have pain and swelling in their fingers and wrists, their knees and feet? Are they all to be branded as suffering from rheumatoid arthritis?

The term chronic infective arthritis has been used as a synonym for rheumatoid arthritis. Boyd (1947) praises the name as “an excellent term which separates it sharply from osteoarthritis” (osteoarthrosis). At the Charterhouse Rheumatism Clinic we speak of “active infective arthritis”, and “true rheumatoid”. The clinical picture we have in mind is that of a person, usually a woman, who is obviously in a very weak state of health. There is general muscular wasting, the fingers show spindle-shaped swelling, the skin over them is glossy in appearance, and there is characteristic ulnar deflection.

The knee joints, on a larger scale, show similar spindle shaped swelling and glossy skin. They are flexed in varying degree, and any attempt to straighten them causes extreme pain. The hips are not usually affected. Constantly or intermittently there are general signs suggesting active infection: malaise, fever, anaemia, palpitations and sweating. Patients with such symptoms sleep badly, and complain that when they get warm in bed their limbs “burn”. Their appetites are poor and they are generally depressed. No source of focal infection can, as a rule, be found, and even if a genuine one is discovered, such as septic teeth, the shock of their removal may make the patient worse, and there is rarely ultimate improvement, unless perhaps in the general health. In such cases gold at times seems to act almost as a specific.

On the other hand, x ray treatment, which likewise is “almost a specific” in early spondylitis, has no beneficial effect. Scott was at one time greatly attracted by the theory that there was a close relationship between spondylitis and rheumatoid arthritis. At that period I had hospital beds at my disposal and we chose 6 cases, which Scott visited and agreed were typical for treatment by the wide-field x ray method which was yielding such good results in spondylitis. The experiment was continued for a year under ideal conditions, for it was possible to give the patients all the rest they

needed and there were no tiring journeys to upset them and so to detract from the possible value of the treatment. Not one of the patients showed any improvement which could be ascribed to the x ray therapy and we regretfully concluded that the experiment was not worth carrying further.

### Diagnostic criteria

Although in an earlier chapter I spoke disparagingly of diagnostic tables I will venture on one now

<i>Ankylosing spondylitis</i>	<i>Rheumatoid arthritis</i>
Occurs more frequently in males (at least 7 to 1)	More frequent in females (at least 7 to 1)
Most usual age of onset 15-30 years	Most usual age of onset 30-45 years
Acute onset rare	Acute onset common
First actual joint symptoms usually in spine early onset in hands extremely rare	First joint symptoms usually in hands
Knees and feet very rarely affected	Knees and feet usually affected
Hip joints commonly affected	Hip joints only very rarely involved
Ulnar deflexion and glossy skin not seen	Ulnar deflexion and glossy skin characteristic
Loss of appetite and mental depression rare	Loss of appetite and mental depression common
X rays show changes in sacro iliac joints	No changes in sacro iliac joints
Bony ankylosis is characteristic	Bony ankylosis rare
Gold while occasionally useful in small doses never has a dramatic effect	Gold has an almost specific act on in some cases
X ray therapy almost specific	X rays useless
Iritis frequent	Iritis rare
17 ketosteroids found in urine in excess	Ketosteroids show little change

No doubt other differences could be listed but the above will suffice. If we are to build up disease concepts from syndromes it would be difficult to find sharper differentiation within the same group—that is of bone and joint affections. It must be admitted of course that one day the bacteriologists or the biochemists might demonstrate a common cause but that day is not yet.

Let us indulge in fancy a little. We envisage a time and place where the medical profession is familiar with some forms of metallic poisoning but not with others. We will quote some pages out of a mythical text book

## CLINICAL DIAGNOSIS

*Neuritis pigmentosa*—A disease characterized by leaden-coloured pigmentation of the skin and a peripheral neuritis. The onset is gradual, and begins with dyspepsia and nausea. An early diagnostic sign is redness and itching of the conjunctiva. Various skin eruptions may appear, and, in the later stages, there is disappearance of the ankle jerk. The disease is usually fatal. It must not be confused with

*Idiopathic extensor paralysis*—In this disease the first symptoms may also be in the alimentary tract—loss of appetite, constipation and, later, colic. A peculiar 'blue line' appears at the margin of the gums, it may precede all other symptoms. When the disease is well established there is paresis or paralysis of the extensors of the wrists and fingers, but the brachio radialis is spared. There may be areas of hyperalgesia, or anaesthesia. Pregnant women suffering from this disease usually abort.

*Aetiology*—Nothing is definitely known of the cause of either disease. Professor A is of the opinion that the cause may be a vitamin deficiency, as in beri beri, where a similar polyneuritis is present. There is, however, in both cases, a greater similarity to the known effects of certain metallic poisons such as mercury. Professor B complicates matters by suggesting that the diseases are due to some unknown heavy metal poisoning which is the same in both instances, clinical differences being due to individual responses. We cannot agree with this, as the distribution of the nerve lesions is quite characteristic, and assuming the cause to be a metallic poison, we believe these poisons are not one and the same.

This imaginary extract from an imaginary text-book is not intended as comedy relief. It may at first sight seem absurd to suppose that a medical science capable of recognizing deficiency diseases should be incapable of diagnosing poisoning by arsenic and lead, but there is little doubt that physicians of the future will be equally astonished at gaps in our own knowledge. What I have tried to bring out is that the syndrome of any form of chronic poisoning may be elevated into a disease if the cause is unknown, but that sharply defined clinical entities usually indicate differing toxic agents.

Apologizing for this fanciful excursion, I return to more practical matters. It is true that both rheumatoid arthritis and ankylosing spondylitis may have as their earliest manifestations vague pains in the limbs. If the sacro-iliac joints show characteristic decalcification, these pains should be regarded as pre-spondylitic. If the sacro-iliac joints are radiographically normal, the case may be one of rheumatoid arthritis. In Great Britain, the public has a great dread of rheumatoid arthritis and the term should not be mentioned in the presence of a patient unless the diagnosis is certain, and not always then.

### Slipped disc

This condition like spondylitis itself, has come prominently before the medical profession only within the last few years. Hernia of an intervertebral disc occurs as a result either of a single major strain, such as lifting a heavy girder, or of a prolonged series of minor strains such as occur in men who carry heavy sacks. The lesion is commoner in men who do manual work than in those of the professional classes. It is, however, doubtful whether this class difference holds for the other sex, as women of all classes are subject to an annual epidemic disease which affects equally all grades of society, and causes a violent desire to shift pieces of heavy furniture. The disease is seasonal, and causes much female disability, including herniated discs.

A person giving a history of acute or chronic strain, and complaining of low back pain radiating over the buttock on one side and extending into the calf or even to the sole of the foot, should be regarded as likely to be suffering from a slipped disc.

Sometimes the history may be vague and the extent of the pain much less, so that the case may as easily be one of spondylitis. A diagnostic point sometimes quoted is that the subject of a disc lesion still has lateral movement of the spine whereas a patient with spondylitis has not. In fact, a spondylitic subject in stage I or early stage II usually has good lateral movement, by the time lateral movement is impaired the diagnosis is obvious. Spasmodic scoliosis, if present, points away from spondylitis. Clinical differentiation is not always possible but radiographic examination should help to clear up the matter. In disc lesions the sacro iliac joints are intact, but it should be remembered that a spondylitic patient, like anyone else, may be the subject of a herniated disc.

If the diagnosis is unconfirmed in cases of low back pain radiating into the buttocks, lateral radiographs should be taken to exclude spondylolisthesis and other abnormalities.

### Summary

Much more could, of course, be written about clinical diagnosis, but I think I have emphasized the main points. The physician will, of course, remember that as well as cryptogenetic spondylitis, there are forms of known origin, produced by the gonococcus, the undulant fever group of organisms and other infections. Finally, iritis should be mentioned—it is much more common in spondylitis than in rheumatoid arthritis and other forms of

## CLINICAL DIAGNOSIS

rheumatism, and is sometimes the presenting symptom for which the patient seeks advice

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## CHAPTER 4

### RADIOGRAPHIC DIAGNOSIS

IN THIS chapter I have made free use of Scott's writings. Not all the inferences which he drew from his findings can be accepted today but from a descriptive point of view his work remains without serious rival.

#### The normal sacro-iliac joint

Although there is little movement between the articular surfaces of the joint it has many of the general characteristics of an articulation. It is partly cartilaginous and partly fibrous. Radio



FIG 2—Anatomical specimen showing the characteristics of A the fibrous and B the cartilaginous section of the sacro-iliac joints

graphically the two sections can be distinguished: the joint is outlined by the anterior and posterior fissures. The effect is that of an outline drawing of a pear hanging downwards: the stalk representing the fibrous portion, the 'body' the cartilaginous section. This radiographic outline does not quite correspond with the anatomical contours of the joint (Fig 2) but this is not of importance from the point of view of diagnosis.



## RADIOGRAPHIC DIAGNOSIS

If we could use the foregoing as an absolute standard of the normal, it would always be comparatively easy to recognize deviation from it. Unfortunately, the matter is not quite so simple. Skeletal congenital variations are common, such as sacralization

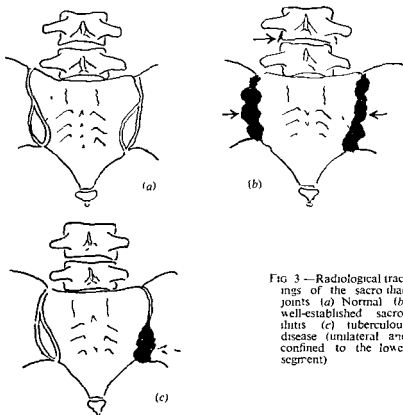


FIG 3 —Radiological tracings of the sacro-iliac joints (a) Normal (b) well-established sacro-iliitis (c) tuberculous disease (unilateral and confined to the lower segment)

and occult spina bifida and such anomalies are often accompanied by departures from the usual appearances of the sacro-iliac joints (Fig 3). Also, until at least the age of 18 years, owing to the fact that the edges of the sacrum are still semi-cartilaginous, the joint outlines, as seen in skiagrams, appear as single, broad fissures with ill-defined borders.

In patients of school age there is no royal road to easy diagnosis. The radiologist should study the sacro-iliac joints carefully in adolescents referred for examination of the bladder, of the colon and of trauma not involving the sacrum, that is, in cases in which

the joints are presumably normal. If he does this, he will gradually *build up in his mind a composite picture of what a normal sacro-iliac joint should look like at various stages of its development* (Fig. 4). When he has accomplished this, he will be able to detect pathological changes even in the early teens.

No satisfactory concept of the normal case can be built up unless the radiographs studied have been taken in a standard

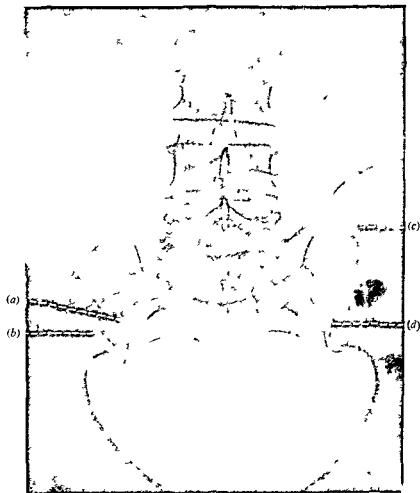


FIG. 4—Normal sacro-iliac joints of an adult showing (a) posterior fissure (b) anterior fissure (c) cartilaginous union (d) fibrous section

position Before basing an opinion on a skiagram, it should be studied with a view to seeing whether the shadows of the spinous processes are centrally placed in relation to the vertebral bodies and whether these bodies are themselves in line with the symphysis pubis The presence of much intestinal gas makes interpretation difficult Scott (1942) states that the standard position should be as follows " the patient on his back and the tube above, centred vertically on a line drawn between the anterior superior iliac spines "

## Sacro-ilitis

The earliest sign of sacro ilitis is a slight loss of definition of the anterior or posterior fissures It may be scarcely more than a personal impression, and, perhaps, not demonstrable to other people The value of such an impression is in direct ratio to the experience and skill of the radiologist, but, if he has experience behind him, he should not disregard it He should report "doubtful" and ask for re-examination in 3-6 months, advising that the case meanwhile be watched clinically Broadening and blurring of the whole joint are the early signs which are more easily recognized and demonstrated (Fig 5)

A little later, but still before spinal symptoms develop, comes a mottling of the cartilaginous section, small rounded cavities may be present, giving a serrated outline to the broadened shadow of the joint When this occurs before there is much broadening, an appearance like a string of beads is produced Scott called this the "rosary effect" (Fig 6) It is not very common

The appearances just described constitute, as it were, the final warning Once the mottling has appeared, spinal symptoms may develop at any moment Scott was originally of the opinion that some degree of ankylosis of the sacro iliac joints always preceded spinal lesions (Fig 7), later he seems to have somewhat modified this view At any rate it is certainly not correct Kennedy, examining 46 cases in which there was radiological evidence of calcification of the vertebral ligaments, found that 17 still showed extensive decalcification of the sacro iliac joints without any evidence of even patchy ankylosis

That is why I speak about a "final warning" The changes described are gross, and to miss them is criminal carelessness For up to this point there has been no permanent damage to joints, no visible deformity, no radiological changes in the spinal ligaments The patient may still be restored to a normal life which

will include all or nearly all his wonted activities. This phrasing is employed deliberately in order to avoid using the word cure. Cure means or should mean that a patient is forever free of his disease. While this desirable state of affairs may at times be brought about in the case of a patient with spondylitis it can never be counted on as the disease may crop up again after many symptom free years of active life. These recurrent attacks may be

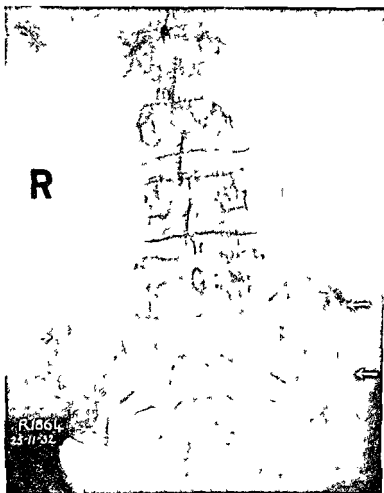


FIG. 5.—Very early spondylitis. These changes may precede the onset of spinal symptoms by several years.

## RADIOGRAPHIC DIAGNOSIS

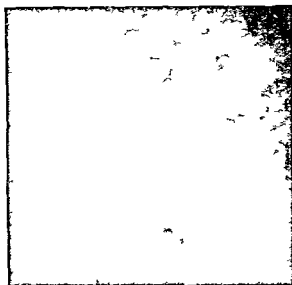


FIG 6—Rosary effect. No spinal symptoms. The involvement of the sacro-lac joints severe and spinal symptoms would normally be expected. It is however obvious that it would have been possible to recognize the changes at a much earlier date.



FIG 7—Terminal advanced ankylosing spondylitis. Illustrating lateral bony ankylosis of the hip joints and sacro-lac joints especially on the left.

very painful but if properly treated do not last long or lead to crippling

The point I wish to lay stress on is that even if the earliest radiographic signs are missed a picture of unmistakable significance appears before it is too late for effective action. This sacroiliac picture may of course also be found where spinal symptoms have already developed. It has only to be looked for diligently and its recognition does not demand that high degree of radiological skill which is required to interpret the initial changes.

If this characteristic appearance is seen in the case of a patient who has been sent to the radiodiagnostic department for some other purpose such as urinary tract examination or radiographic evidence of injury it should be reported forthwith with emphasis on its meaning.

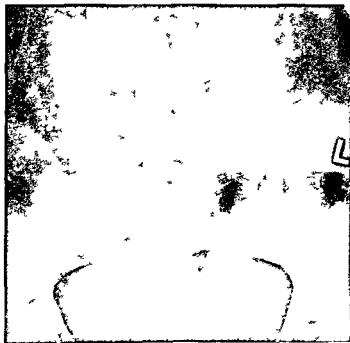


FIG. 8.—Extensive irregular decalcification of left sacroiliac joint. Slight but similar changes on right side. These might easily be missed and the condition be regarded as unilateral. This again might arouse a suspicion of tuberculosis but the involvement of the whole joint is presumptive evidence against it. Unless there was severe localized pain.

*Tuberculous sacro-iliitis*

The type of sacro ilitis I have been describing may sometimes show itself in the first place as a one sided lesion. Hence may arise the possibility of confusion with tuberculosis especially if only the cartilaginous portion of the joint is involved (Fig. 8). Purely radiological differentiation may at this stage be impossible, but if, with these appearances there is a painful and very tender joint, it is not spondylitic. On the other hand bilateral changes involving the whole radiographic outline are never tuberculous.

*The hip joint*

Scott (1942) states that of 300 cases of spondylitis which he investigated 10 had been wrongly diagnosed as tuberculosis of the hip and these 10 patients had been immobilized in plaster for several months. Complete ankylosis had occurred in all. I have no exact figures for my own cases but I have certainly found a similar state of affairs in several of them. We may take it that up to the present time some 3 per cent of all treated spondylitics have suffered this fate. True, in rare cases it may be impossible to prevent ankylosis whatever is done, but I doubt if such cases constitute more than 0.5 per cent of all those seen. Two and a half per cent may not sound impressive but it connotes an enormous amount of human misery.

It must be said at once that there are no radiographic criteria which can be relied upon in the very early stages. Nothing at all abnormal may be seen, or only a patchy rarefaction which is not characteristic. The only safeguard is that before putting a suspected hip in plaster, a careful examination should be made of the sacro iliac joints.

Spondylitic hips in the later stages of the disease are not likely to be confused with tuberculosis. But they are scarcely distinguishable radiographically from ordinary osteoarthritis of the hip, which, contrary to what is generally thought may occur in the third decade of life. Not only does Nature fail to provide us with a sufficiency of symptoms for our neat classifications she is also *niggardly of radiographic signs*. Osteophytes are less often seen in spondylitic hips, but loss of cartilage is common to both conditions.

Again, the sacro iliac joints must be examined.

The same advice holds good in the case of tuberculosis of the spine. This is very rare in adults between 80 and 90 per cent of all cases occur before the age of 10 years.

**Osteoarthritis of the spine following trauma**

This disease is characterized by a narrowing of an intervertebral space or spaces. Sometimes the anterior part is almost obliterated. If it occurs on one side, the alignment of the vertebrae is affected. Prolongations from the margin of the vertebrae may occur. Osteoarthritis of the spine is most likely to be found in the middle decades of life, and the history of accident is elicited only by questioning, or there may have been no accident but only some continued occupational stress.

**"Old man's spine" (spondylosis)**

The radiograph of a case of spondylosis shows a general curvature of the spine. There is much lipping of the spinal bodies, osteophyte formation, and narrowing of the anterior portion of the intervertebral spaces. There is no deposition of calcium in the spinal ligaments. As I have previously remarked, there are a few cases in which ankylosing spondylitis does not show itself till an age at which spondylosis is fairly common. In ankylosing spondylitis there are seldom osteophytes, and the width of the intervertebral spaces is not affected.

**Calcification of vertebral ligaments without other spinal lesions**

Parr and Shipton (1946) call attention to Oppenheimer's observations on this point. In 17 patients over 55 years of age he found ligamentous calcification resembling that which occurs in spondylitis, but these patients had never presented any symptoms, and the condition was discovered accidentally. We know that a man may develop a complete "poker back" and be unaware of it, so that it is possible that these are merely examples of a naturally aborted spondylitis in people of high resistance.

What, then, is the conclusion of the whole matter? A rule at the Charterhouse Rheumatism Clinic says that all patients under the age of 25 years who complain of rheumatic symptoms must be sent for radiological examination of the sacro-iliac joints. It is an excellent rule, but might with profit be extended to cover an extra 5 years. The radiographic key to the diagnosis of the clinical entity known as ankylosing spondylitis is in the sacro-iliac joints. This is the whole Law and the Prophets. The rest is gloss.

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FIG. 9—Old standing spondylitis in a patient aged 35 years. Complete ankylosis of sacro-iliac joints. Right hip shows very early changes: slight narrowing of joint space and a small osteophyte on the femoral head. No hip symptoms, walking perfect. The patient attended again 6 years later, saying that for some months he had had pain on walking.

FIG. 10—Same patient as in Fig. 9 after a year's interval. Complete ankylosis of hip joint. No movement, especially extension and adduction. Muscles control these movements in spasm. Spasm relieved by intra-muscular and intra-articular injections of procaine. Joint movements greatly extended. Later deep X-rays localized ankylosis. Clinical results very satisfactory. X-ray picture unchanged.



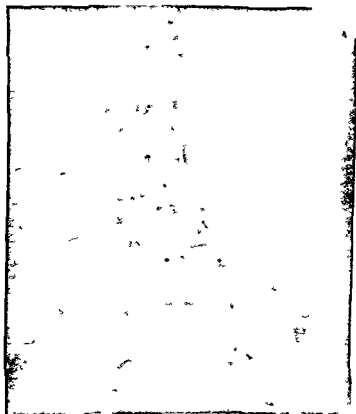


FIG. 11—Spondylitis complicated by scoliosis of lumbar spine. This radiograph was taken to confirm a diagnosis of scoliosis to which it was thought the symptoms were due. The radiograph revealed advanced sacroiliitis on the left side with nearly complete ankylosis and early sacroiliitis on the right side.

## RADIOGRAPHIC DIAGNOSIS



FIG. 12—Same case as in Fig. 11. Both sacro-iliac joints are shown in full. Decalcification predominates on the right side.



FIG. 13—Early sacro-iliac changes in young man aged 18 years. Pain complained of in both back and limbs, but no deformity or limitation of movement.

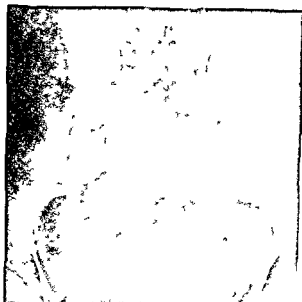
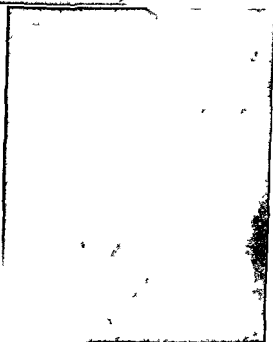


FIG 14 — Note bony sclerosis in neighbourhood of both sacro iliac joints. The appearance simulates that of sacro ilitis at a stage when the joints are beginning to ankylose. The case however is not one of spondylitis but of sacro iliac strain due to a leg injury. The picture is complicated by sclerosis on the right side.

FIG 15 — Old standing spondylitis with ankylosis of C2 to C5. Head movements practically absent. C6, C7 and C8 are free. Sometimes this distribution is reversed and the patient may then be scarcely conscious of disability.



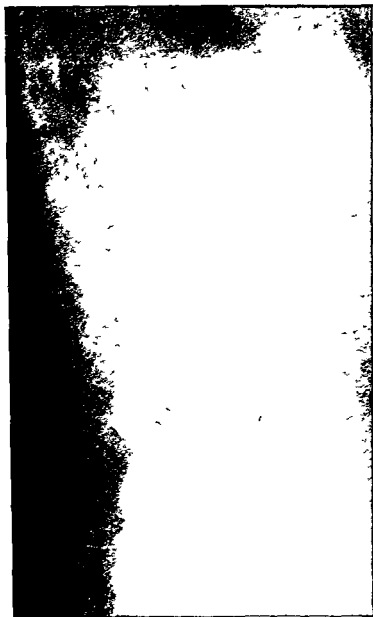


FIG 16—Commencing bamboo spine. Calcification of ligaments between L3 and L4. Note complete straightening of normal lumbar curve.

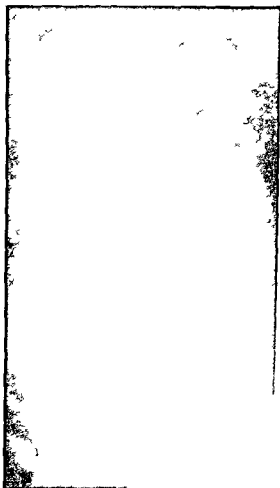


FIG 17 —Bamboo spine lateral view. Note wide intervertebral spaces as compared with senile arthritis (arthrosis) in which the spaces are narrowed or absent.

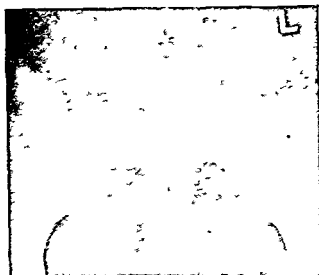


FIG. 18 — Complete ankylosis of sacroiliac joints. No sign of calcification in spinal ligaments. No limitation of movement.



FIG. 19 — Ankylosis of sacroiliac joints. Remains of rosary effect just visible on right side. Commencing bamboo spine complete between D 12 and L 1; unilateral between L 1 and L 2; bilateral but incomplete between L 2 and L 3. Note wide intervertebral spaces.

## CHAPTER 5

### SOME REFLECTIONS ON TREATMENT

THE PROXIMAL cause of the greater part of organic disease is the presence of a circulatory poison. A great many of the poisons which affect us are of external origin, mostly, of course, microbial, but the body itself, when its delicate adjustments get out of gear, has an unfortunate capacity for making poisons of its own.

#### Poisons and toxins

The word poison is generally applied to harmful substances of mineral origin, to lethal extracts from certain plants, and to glandular secretions, such as snake venom, of an offensive or defensive character. On the other hand, the word toxins is used to indicate the products of bacterial activity within the body, for example, diphtheria toxin. This distinction is, however, to a large extent artificial. No real dividing line can be drawn between external poisons of organic origin and microbial toxins. Ricin and certain other vegetable substances result in the production of antibodies, so likewise does snake venom. On the other hand, bacterial toxins may be artificially prepared in culture media, and when injected into the body produce the symptoms of their proper diseases.

By far the greater number of poisons which plague the human frame are of microbial origin. Not only have we to deal with the toxins of the specific fevers, which attack impartially the feeble and the robust, there are also disease-producing organisms which can become pathogenic only if the resistance of the body is in some way lowered. Domestic fowls are normally resistant to anthrax, but if their vitality is lowered by cold they may become susceptible. In man, when worry or mental depression results in disease, the immediate morbid agent is usually a toxin. For instance, a person receives bad news, and the secretory cells of his alimentary tract cease to function. If this condition lasts long, fermentation results. The late Lord Dawson used to say that, whenever the market fell, he had a crop of cases of what he called "stock brokers' diarrhoea." In some instances this might proceed to actual ulceration of the gut accompanied by a general toxæmia.

The above is an example of the indirect production of toxins by mental disturbance, but it has been shown experimentally that an



infuriated dog develops in its blood "anger toxins", which cause illness if injected into normal dogs

It is, in fact, very difficult to be sure that in any disease the mediate or immediate cause is not a microbial toxin. In the case of hyperfunction or hypofunction of a ductless gland a toxin may have upset the gland, and the same applies to idiopathic disturbances of metabolism such as characterize gout. The primary degenerations of the nervous system are suggestively like the syndromes which lead us to suspect poisoning by certain heavy metals, or by known toxins.

It may almost be said that the classification of disease is a branch of toxicology, and has reached finality only when each symptom complex can be definitely associated with a particular toxin.

### **Bacterial and immunological considerations**

It is safe to regard a given bacterium as the cause of a disease provided we keep in mind that what we really mean is that there can be no disease (that is, no toxic syndrome) without the presence of the bacterium. Sometimes the microbe is, for practical purposes, the sole cause of the trouble. I say for practical purposes, for even the most virulent organism, such as *Bacillus pestis*, does not infect all who are exposed to its attack. At the other end of the scale is the tubercle bacillus, which probably fails in the majority of its assaults, and is greatly affected by the resistance of the patient.

In cases in which the essential microbe is known we may be able to prepare an antitoxin which chemically neutralizes the toxins circulating in the blood. If we cannot do this, we may make use of our knowledge to attack the microbe indirectly. The body has a formidable array of weapons, such as agglutinins, anti enzymes, bacteriolysins, precipitins, opsonins, *et hoc genus omne* which it brings to bear on invading organisms. The injection of preparations of the dead bodies of suitable organisms stimulates the production of all these weapons, and may turn the scale in favour of the patient.

The efficiency of such a vaccine as a curative agent differs enormously according to the organism concerned. In the case of staphylococci, for instance, it may act quickly and surely. One expects to be able to abort a generalized furunculosis. At the other end of the scale stands tuberculosis. Tuberculin, which is tuberculosis vaccine, has proved a great disappointment in its effect on established disease.

Preventive inoculation, introduced into medicine largely by the efforts of the late Sir Almroth Wright, is a procedure wider in its scope and more certain in its results than treatment by vaccines. Killed germs are employed as in vaccine therapy. The effect is to produce an active immunity (as opposed to the passive immunity brought about by antitoxin) similar in kind to that which follows an attack of the particular disease concerned, but not so long-lasting. Wright for many years held the view that such immunity was narrowly specific. For example, typhoid vaccine will not protect against paratyphoid, and *vice versa*. But eventually he changed his opinion. I make no apology for quoting his remarks on this subject, although they were first published 30 years ago (Wright, 1919).

I confess to having shared the conviction that immunization is always strictly specific. Twenty years ago, when it was alleged before the Indian Plague Commission that anti-plague inoculation had cured eczema, gonorrhoea, and other miscellaneous infections, I thought the matter undeserving of examination. Again, several years ago, when applying pneumococcus inoculations as a prevention against pneumonia in the Transvaal mines, I nourished exactly the same prejudices. But here the statistical results which were obtained in the Premier Mine demonstrated that the pneumococcus inoculations had, in addition to bringing down the mortality from pneumonia by 85 per cent, reduced the mortality from other diseases by 50 per cent. From that on, we had to take up into our categories the fact that inoculation produces in addition to direct, also collateral immunization. This once recognized, presumptive evidence of collateral immunization began gradually to filter into our minds.

When they read this recantation the feelings of the physicians who had presented the clinical evidence of collateral immunization before the Plague Commission in 1899 can be better imagined than described. Note that Sir Almroth Wright on that occasion did not merely say, "I don't believe it", he said "I thought the matter undeserving of examination" and he maintained this attitude for 13 years.

We may forgive the man of genius for intolerance, but not lesser men for imitating him. How many views which are heretical today will be orthodox tomorrow? I remember some dozen years ago seeking to interest a very distinguished radiological colleague in the treatment of spondylitis by radiotherapy, describing to him some remarkable recoveries. He looked at me pityingly, and said "Of course, I'm sure you think it is as you say, but I don't believe a word of it!" In Sir Almroth Wright's phrase, he "thought the matter undeserving of examination".

The moral of all the above is that it is dangerous to disregard careful clinical observations, even though the results claimed may seem impossible in the light of some pet theory

### Chemotherapy

Another form of therapy, to some extent specific but having also collateral action, has been greatly developed within the last 15 years. First came the sulphonamide drugs, giving dramatic results in streptococcal diseases. But before long it was evident that sulphonamide-resistant strains of bacilli were being developed. This should not surprise any philosophically minded person. Living things possess the power of adaptation, if they are given time to bring it into play. Driven by some directive idea, the nature of which we can only guess at from its results, all organisms strive ceaselessly for the perpetuation of their kind, and the so called parasitic diseases represent a clash of living instincts which is as genuine a conflict as a war between hostile nations. This warfare has been going on for countless generations, and even now the outcome is uncertain. If, as seems not unlikely, the nations make use of bacterial warfare, they may well share the usual fate of those who call in dangerous allies.

The same phenomena of bacterial adaptation are being repeated in the case of penicillin. already we are beginning to hear of penicillin resistant strains of bacteria.

### A conception of the ideal treatment

From our discussion so far we arrive at a conception of ideal treatment. (1) To be able to employ an antitoxin which will immediately neutralize the effects of a bacterial toxin circulating in the body. (2) To employ some remedy which will forthwith kill or at least render static all the existing microbes without injuring the host. We may do this (a) indirectly, by a vaccine or (b) directly by chemotherapeutic means, as with a sulphonamide, or by a biochemical method, as with penicillin.

In some instances we get very near to this ideal treatment, but it should never be forgotten that even in the case of specific chemotherapeutic remedies, success is not altogether a matter of chemical affinities, but involves also the body as a whole. As long ago as 1906 the medical service of the Royal Navy dealt with patients with syphilitic cachexia which had ceased to respond to mercury by sending them for a time to a convalescent home, and giving them a regime such as is employed in a sanatorium for

tuberculosis. It was found that after a few weeks mercury might be again exhibited with success.

Let us assume that spondylitis is the syndrome of an unknown microbial toxin. Evidently no specific antitoxin can be used, so that ideal treatment is not possible. But what about the sulphonamide drugs and penicillin? So far as I know, they are useless. But we have seen that organisms belonging either to the tuberculosis group or to the undulant fever group are under suspicion, and these microbes are known not to respond to either form of medication, nor do virus diseases so respond.

### Non-specific treatment

If all forms of specific therapy are inapplicable, how is it that we can and do employ remedies which favourably affect spondylitis? X-rays, radioactive thorium X, vaccines, gold, bismuth—a varied and at first sight unrelated list—are all of proved value. There must be, of course, a common factor, and it is this: all the above agents are capable of affecting the reticulo-endothelial system, which means the reticular epithelium in liver, spleen, bone marrow and lymph glands. It is this epithelium which is chiefly concerned with furnishing defences against microbial attack. It is responsible for immunity and resistance.

### Evaluation of treatment

X-rays and all the rest are depressants of the reticulo-endothelial system if given in large doses. In correct dosage they stimulate resistance. In the case of a vaccine we may get this beneficial effect even if the specific organism is not in its composition. This is an example of collateral immunization as accepted by Wright in his later years. But what is correct dosage? This is the nub of the whole question, and I venture to say that failure to appreciate this fact is the basis of much controversy. The trouble is that *ex cathedra* statements about dosage are impossible. In the case of vaccine, the dose required by one patient may be 10,000 times less than that required by another, even in the case of the heavy metals: ratios between individual patients may be at least 20:1.

Each patient, then, requires individual study, and even when a helpful dosage has been found, it is necessary to watch results carefully, for, sooner or later, any non-specific remedy is likely to lose its effects. Hence, we must be ready to apply the principle of variation of stimulus. This has its most obvious applications in the treatment of sluggish wounds in which the type of dressing

should be frequently changed or the wound subjected to some entirely new form of stimulus, such as x rays or light

It might be thought that when, for instance, the reticulo-endothelial system begins to fail in response to, say, gold, it would be useless to employ vaccines. But in fact it is not so, and we must remember that the word stimulate may not precisely describe what goes on, "favourably affect" might be a sounder phrase, but it is rather too ponderous for frequent use. However, a case which has ceased to be favourably affected by gold may nevertheless respond to other stimulants.

When a considerable number of remedies are recommended for the same disease, the cynic is apt to scoff, and to say that obviously none of them is of any use. But when we are dealing with mere resistance raising agents, there is safety in numbers. One agent is almost sure to fail, though perhaps not for a long time, two, allowing alternatives, stand a chance of retaining their effects. But a range of four or five possibles makes it highly probable that control may be indefinitely prolonged.

### Sociological factors

We must, however, realize that, when we do not know the cause of a morbid state, control is merely a balancing of forces, and the equilibrium is necessarily unstable. The success of remedies is dependent upon the integrity of the defensive mechanism which they call into play, and this mechanism is but part of the individual patient, which means that it may be affected by external causes both physical and mental. Anything from an attack of influenza to an unhappy love affair may tip the balance. It is very far from being within the power of the physician to shield his patient from the vicissitudes of life, but at least he should bear them in mind, and seek to alleviate them where possible.

The cured spondylitic patient who is fortunate enough to find himself in a congenial occupation which is not too strenuous and who is happy in his human relationships, may remain cured for years, perhaps indefinitely. On the other hand, the overworked and worried patient may be kept going only by unremitting therapeutic attention. And sometimes, if the unfavourable circumstances cannot be changed, it may be impossible to stay the course of the disease.

Finally, there are a few cases in which the disease is of a fulminating type. We are familiar with such instances where tuberculosis is concerned, we say "the patient has no natural

resistance", and it is probable that this is the explanation also in the case of "galloping" spondylitis, rather than any special virulence in the hypothetical germ invasions. In these tragic cases the malady runs its whole course in 2 or 3 years, and in this brief time changes an athletic youth into a hopeless wreck.

But it must not be thought that this gloomy picture is other than a very rare exception. Only once or twice in a long experience have I seen this deadly march of events in cases which had come under treatment at a reasonably early stage. Looking back, I feel that one remedy which might have succeeded was not used, largely because of war conditions. I refer to repeated transfusions of whole blood, a method of which I shall say something later.

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## CHAPTER 6

### X-RAY TREATMENT

TO THE physicist, x-rays are merely a form of light differing only in their wave-length or frequency from that appreciable by our eyes. The wave-length of x-rays, and consequently their capacity to penetrate the body, is determined by the voltage at which they are produced. In the early days of the century this voltage was comparatively very low, and the earliest therapeutic use of x rays was in the treatment of diseases of the skin. But the tubes of the period were unshielded, and their construction was such that the whole of the hemisphere on the active side of the anticathode emitted radiation. Patient and operator were alike exposed to widely dispersed radioactivity and only the comparative feebleness of the output prevented widespread disaster.

Owing to the lack of penetration of the rays used, very long exposure was required in the early attempts to radiograph the kidneys, and severe burns resulted. On the general principle that what does harm in very large doses may be beneficial in small ones, x-rays were soon tried in skin diseases, and found to be efficacious in their immediate effects. The realization of the possibility of trouble at a later date came only with experience.

#### 1 LOCAL EFFECTS OF X-RAY THERAPY

A search through the early literature shows that practically all the therapeutic possibilities of x-rays were envisaged during the first 5 or 6 years of this century. These possibilities are as follows.

X-rays have a resolving effect upon inflammation whether acute or chronic. They possess a power of 'regulating' fibrous tissue formation and the activity of ductless glands.

#### Acute inflammation

The most outstanding instance is, perhaps, the effect of minute doses—few r units, to speak in present-day measurements—on erysipelas. Before the advent of the sulphonamide drugs this was the only known method of aborting the disease.

Less spectacular, but not less interesting, were the observations made by Preston Hickey on the therapeutic effect of diagnostic exposures on patients with pneumonia. Those who had been

radiographed showed a mortality rate appreciably lower than did those who had not been subject to x-rays

### **Chronic inflammation**

Indolent ulcers, especially varicose ulcers, may be caused to heal in a few weeks, although they may have shown no improvement after many months of rest and surgical dressing

Wounds which are septic and chronically inflamed, and sluggish despite efficient drainage, will often heal quickly under suitable x-ray treatment

### **Fibrous tissue**

X-rays can cause the absorption of pathological fibrous tissue. One of the earliest demonstrations of this was in the case of keloid, in which the cosmetic effects are excellent

Conversely, x-rays promote the formation of fibrous tissue where such formation is necessary for defensive purposes. In cases of cutaneous cancer, the tumour gradually shrinks under treatment, and, if a biopsy is performed, it is found that the malignant cells have been strangled by an invasion of fibroblasts

The above instances have been chosen because they are visible and tangible and are of such a nature that checking by the microscope is an easy procedure. The observed results can be summed up by saying that x-rays locally applied to the surface of the body stimulate Nature's mechanisms for resistance and repair. To say that they increase vascularity, or decrease vascularity, or that they cause absorption of fibrous tissue, or an increase of fibrous tissue, is to miss the point. Any of these things may occur, but they are incidental

### **Thyroid gland**

The action of x-rays should perhaps be spoken of as regulating rather than stimulating. The latter word is not very suitable to describe the action of x-rays on keloid, and quite unsuitable if we wish to describe their action on an over-active thyroid gland. Here, the pulse rate may come down from 140 to 80 or 90 within a few weeks, and the size of the gland may visibly diminish. It used to be said that this was accomplished by a destruction of active gland substance which was replaced by fibrous tissue, but it is now agreed that this is not the case except when there has been severe and prolonged overdosage. The rapid change is functional, not organic, and if we say that x-ray treatment regulates



the action of the thyroid gland we shall be using a descriptive term which fits the facts

### **Indirect or non specific effect**

It is of the utmost importance to realize that the action of x rays on disease is indirect and non specific. As Scott (1942) said by the use of specific drugs we attack a particular microbe by the use of x rays we help the body to make the best use of its own weapons. Successful results have been claimed in a whole alphabet of diseases from acne to zoster but no permanent success has ever been obtained by radiation in maladies which untreated always end fatally. Sometimes the reason for this is now obvious as for instance in the case of pernicious anaemia. The aetiology of the leukaemias of disseminated sclerosis and of syringomyelia is still unknown all we know is that they invariably end in death despite periods of temporary improvement. Remissions may occur naturally but we may bring them about artificially by x rays and when the disease is non fatal in its essence and at times subject to spontaneous cure radiation may have an effect which imitates that of a specific. Ankylosing spondylitis is an excellent example of the latter class.

### **Osteoarthritis**

I have said that soon after the discovery of x rays it became evident that they had a resolving power in surface inflammation. Technical progress very soon furnished tubes capable of working at 100 000 volts or more and it naturally occurred to x ray workers to try the effect of irradiation by x rays on inflammatory processes within the body. To Professor Kalbruck of Stockholm belongs the credit of bringing x ray treatment of osteoarthritis to the fore. Various attempts have been made to correlate radiographic findings with the results of x ray treatment in order to find a basis for prognosis. I myself analysed 100 cases of osteoarthritis of the hips from a radiotherapeutic department under my charge. I found that between one quarter and one third of these patients had received striking benefit and that among these were several in whom the radiographic appearances were appalling. On the other hand among those who made little progress were some in which the joint damage as shown in radiographs was comparatively small.

A similar investigation of knee joints had the same negative result as regards ability to prophesy results in an individual case but showed that more than 60 per cent were markedly improved.

It is often asserted in text-books of medicine, even where x-ray treatment is recommended, that pain is relieved but the disease itself is not affected. In the really successful case, this is a misstatement. It is true that pain may vanish in a few weeks, and that walking may improve, without any change in the x-ray picture. But if a case in which x-ray courses have been given at intervals over a period of years, during which the patient has steadily improved, is radiographed year by year, it will be found that pathological bone deposit has been absorbed, and new buttresses have been formed to take the stresses transmitted by the head of the femur in its final position. I was particularly fortunate in being able to collect radiographs of an osteoarthritic hip 3 years before x-ray treatment was commenced and during 3 years of x-ray treatment. The first series showed a steady deterioration, the head travelling upwards, and the lower part of the acetabulum being filled with a new deposit of bone. The second series showed a gradual absorption of the pathological osseous tissue and, at the same time, the reconstitution of the joint at a higher level. Clinically the history was that of a man of 65 years who had been compelled to give up golf and fishing. At the end of the second 3-year period he had resumed both these hobbies (Herniman Johnson, 1937).

I have dealt with osteoarthritis at some length in order to show that x-rays may, in certain circumstances, produce favourable organic changes "in the depth", just as they do in surface lesions. In cutaneous lesions their healing effect is very constant. In osteoarthritis of the knee it falls to 60 per cent, and in osteoarthritis of the hip the figure is reduced to 30 per cent or less. The facile explanation is that surface lesions can be more effectively dosed but it is possible with modern technique to give to a hip almost any desired dose. Scott would have said that as it is necessary to use a much shorter wave-length, the rays which reach the hip joint have proportionately less therapeutic value. But this explanation will not hold water. In the first place, although the "primary beam" may be "hard", it produces in the tissues enormous quantities of secondary radiation of long wave-length, and, secondly when x-rays act with a high degree of efficiency, as in spondylitis, it does not seem to matter much whether their wave-length corresponds with 100,000 or 200,000 volts.

Sometimes failure may be due to lack of rest for the joint treated. We should not expect to heal a varicose ulcer by x-rays if the patient were neither resting nor wearing an efficient bandage, yet we set out to treat osteoarthritis of the hip in out-patient

departments into which the patient hobbles after a long martyrdom in bus or train<sup>1</sup>

## 2 TOXIC EFFECTS OF X RAY TREATMENT

All I have said so far has been concerned with the local effects of x rays, that is, local destruction of tissues or advantageous stimulation according to dosage. But there is also to be discussed what may be called the toxicology of x rays. Heavy dosage over a large area causes the death of lymphocytes, and, it may be, the breaking up of red cells also. If the dosage has been really excessive, death may result, but, as a rule, regeneration begins in a few days, and the blood picture is restored, or even improved, after 2 or 3 months.

When small doses are absorbed by the whole body over a period of years, as occurred with the early x-ray workers, a fatal aplastic anaemia may suddenly develop. It is, however, notable that many persons who developed chronic x-ray dermatitis, not only in the hands, but in the face and over much of the front of the body, and who were completely sterile, never developed serious blood changes, although they must have absorbed large quantities of x-rays over a long period.

The spleen, the liver, the lymphoid glands and the bone marrow—in other words, the reticulo endothelial system—can be powerfully affected by doses which produce no skin reaction, provided the field is wide. A widely distributed dosage must also reach various ductless glands and we know that these are sensitive to x-rays. It should not, therefore, surprise us if we find that an agent capable of doing such widespread damage should be potent for good if properly employed. Strychnine is a deadly poison, but in small doses it is a valuable tonic and restorer of nervous energy. While it is not true to say that every substance capable of doing harm has also a therapeutic value, it is at least true that seldom do we find a worth-while remedy which is not toxic if given in excess.

## 3. WIDE-FIELD METHOD OF X-RAY THERAPY

Scott says that he was not led to try x ray therapy in the treatment of spondylitis as a result of success in the localized treatment of osteoarthritic joints. He came to the conclusion at an early date in his investigations that spondylitis bore resemblances to tuberculosis, and that the resistance of the patient was of prime importance. He had been impressed with the effects of small doses of

x-rays given over a wide field in conditions as diverse as asthma, generalized metastasis from breast cancer, and premature senility in women past the menopause. He therefore decided to try the method in the treatment of spondylitis. His success was such that x-rays have come to be recognized as standard treatment.

This is not the place to enter into a controversy as to what method of radiotherapy should be used—whether Scott's wide-field therapy or deep therapy of the whole spine. It is not practicable to give wide field treatment without the possibility of local action, still less is it practicable to irradiate the whole spine over an area 4 inches wide without producing constitutional effects. It is, however, a matter of historical fact that Scott's work was wholly responsible for the use of x-rays in any form. The wide-field method, however it acts, proved capable of converting a sceptical world: its absolute value, as opposed to its relative value, therefore cannot be doubted. I myself use both methods, and personally believe that constitutional effect plays a large part in the results, and I am confirmed in my belief by the fact that injections of thorium X, in cases in which there can be no question of local effect, give many of the results of x ray treatment.

The matter is of practical importance. It should be remembered that x-ray treatment for the first quarter of a century of its existence was carried out with the same apparatus as that used for x ray diagnosis. In certain parts of the world there may even now be no deep-therapy apparatus available within hundreds of miles, yet there may be a local hospital close at hand which possesses a diagnostic set.

*It must be admitted that, in Great Britain, the wide-field method has made little progress.* Our radiotherapists, after the introduction of deep therapy in the nineteen twenties, became obsessed with the idea of the lethal dose in the treatment of cancer, and for many years few of them took any interest in anything but malignant disease. They believed that if only enough radiation could be directed into a tumour, its cells could be directly destroyed. I spent a great part of my professional life in combating this, to my mind, erroneous view, and endeavoured to point out, without much success. I fear that, whatever the dose, its main effect was to stimulate defensive reaction in the surrounding healthy tissues. Where the primary tumour only was concerned, the argument was perhaps rather of theoretical than of practical interest, for very often the growth did disappear under drastic local x ray treatment. The patient was made very ill, but usually recovered, and re-

maintained well until the advent of metastases. If these were widespread, as in the case of metastatic invasion of the spine and of the ribs in breast cancer, the advocates of the lethal dose shrugged their shoulders, and said they could do nothing further. Both Scott and myself, however, kept many such patients alive and at work for years by widefield methods, using doses even smaller than those advocated for spondylitis, this was also the experience of la Marque of Montpellier.

As a result of this fixation, in Great Britain the now widespread use of x-rays for the treatment of spondylitis has taken the form of intensive treatment to the spine as a whole, the idea being, I suppose, to "kill" the disease. I have seen many cases of serious damage by this method, the resistance of the patient being minimized for months, so that he could not respond to any form of treatment. But experience has led to a general modification of the dose, and very good results have been obtained by the method. It can be of great value in the second stage of spondylitis in facilitating the reduction of spinal deformity due to fibrous adhesions, being in this respect superior to wide field therapy.

But, "A prophet is not without honour, save in his own country, and among his own kindred." Scott's original method appears to be practised extensively in the Colonies and in the Dominions, and with gratifying success.

I shall now describe the wide field method as I have practised it since 1932. It is, of course, basically the method of Scott, and that which he himself used for many years. Later, he modified it by reducing the kilovoltage and practically abolishing filters, a practice which I have not followed.

### Technique

The old type of Coolidge tube was ideal for wide-field treatment, as it sprayed out x-rays from practically every part of its surface. It was, of course, necessary to place it in a heavy protective box, and this raised some mechanical problems, but it was easy to leave one opening which at a distance of 20 inches gave a field equal to the length of an average trunk.

Modern self-protected tubes, however, have a very limited aperture, and the diameter of the field does not exceed, as a rule, half the anode-skin distance. To include the whole trunk therefore requires that the aperture be placed a little over 20 inches from the skin, and that the exposure be stopped midway in order to readjust the position of the tube.

The lower half of the trunk is covered with a thick sheet of lead rubber, the upper edge of which is carefully marked. If the total dose is intended to be 60 r on the whole trunk, 60 r is administered to the unshielded area. The lead rubber is then transferred to the upper half of the body, and the dose is repeated on the lower half. It is necessary to be sure that there is no area of skin which receives rays in both positions of the tube, the lead rubber should therefore overlap the midline mark by at least half an inch.

A 3-millimetre aluminium filter is used, and the milliamperage is generally about 4, a smaller milliamperage may be used, but this involves a correspondingly longer exposure. As spondylitic patients are often uncomfortable when lying on their faces, the question of time is important.

#### *Position of the patient*

It is convenient, but not essential, for the patient to lie on his face. If this position causes much discomfort, the patient may lie on his side. Indeed, there is no theoretical objection to the supine position, but practical experience has shown that x-rays applied to the front of the abdomen cause much more digestive upset for a given skin dose than when applied to the back. It may be that the answer to this would be a reduced dose, with equally good results as regards the spondylitis. It is an experiment I have not tried.

#### **Factors influencing dosage**

When only a single agent is concerned, it might seem that dosology would be simple. In fact, x-ray dosage is a somewhat complicated matter. It involves the questions of wave length, area exposed, filtration, and, of course, r units on the skin. These factors arise for the administration of a single dose. But when a course of treatment is to be given, many other factors must be taken into account. These include the number of sittings, the spacing of the exposures, and the interval between and the total number of courses.

It must be said at once that no hard and fast routine can be laid down, any more than it can be in the administration of vaccines or of gold. Where the latter is concerned, it is true that the manufacturers furnish neat little boxes containing a series of ampoules of increasing strength, the whole constituting a standard course. This penny-in-the-slot method, while no doubt working well enough in some cases, has brought much undesired disrepute upon a valuable form of medication.

*Overdosage*

When we use x rays for constitutional action we are, in effect, using a powerful drug, and the same care and adaptation to the individual patient is required as in the use of the heavy metals. At the risk of being charged with redundancy I must again emphasize that x-rays act on the patient, not on the disease, and that overdosage may result, not in stimulating, but in actually depressing his powers of resistance.

What is overdosage? No definite answer can be given in terms of physical units. It is true that an average dosage which is suitable for a large percentage of patients has been worked out by experience. But quite a number find the average too much, and a few require more to get the best results. Unfortunately, there is no means of telling in advance the way in which an individual patient will react, although it is obvious that a patient who is running a temperature, and has a much raised blood sedimentation rate, must be treated with particular caution.

## 4 X RAY TREATMENT OF PATIENTS IN STAGE I

Wide field x ray therapy has its greatest value in the treatment of patients in stage I of ankylosing spondylitis—that is, patients with no spinal symptoms but with “wandering pains” in the limbs, and with radiological evidence of sacro-iliitis. This is, of course, ideally the stage at which all patients with spondylitis should be treated. Such patients are usually in fair general health, and able to visit an out-patient clinic without undue fatigue. Very often they are at work, and say they can attend only once a week.

In theory we should not be influenced by this, but should insist on the most favourable conditions for treatment. In practice, we are dealing with human beings who have their individual cares and anxieties. Financial worries bulk largely in their minds, and it is of little use to insist on bodily rest if the mind is made uneasy. Therefore, in the case of patients whose work is not very tiring, and who do not have to make long fatiguing journeys, it is best to be content with weekly treatments.

Let us suppose, then, that we have a patient so situated and without spinal symptoms.

*Dosage*

We start with a cautious dose of 30 r on the upper half of the body (kilovolts=130). This will most likely produce no reaction of any kind.

The following week, we give 30 r to the lower half of the body. Again, there will be no reaction, except in sensitive subjects. Having assured ourselves that the patient has no special idiosyncrasy to x-rays, we proceed to give him 10 further weekly treatments of 60 r to each half of the body—a total of 60 r to the whole trunk at one sitting.

The body will therefore have received 660 r at the end of 12 weeks. Before the course is finished some of the phenomena of what Scott called x-ray saturation may have manifested themselves. The patient may suffer from slight nausea, and complain of loss of appetite. If he is a smoker, he may complain that tobacco has ceased to give him any pleasure. These symptoms are to be considered normal, and are not a reason for stopping or modifying the x-ray treatment. It should always be explained in advance to the patient what is likely to happen.

In a few cases, if the subjects are neurotic, the explanation may itself lead to the development, in an exaggerated form, of the symptoms prognosticated. Records of weight, haemoglobin percentage, white-cell count and blood sedimentation rate should always be taken before treatment is commenced. In some cases, weight is gained during the actual course, in most, however, it remains steady, or even shows a slight loss. Any diminution of weight of more than a few pounds calls for modification of treatment. Patients who show little loss of weight and no deterioration of the blood picture should be reassured and encouraged to continue, despite discomfort. It is well, however, to cut the dose by 10–20 per cent, and to inform the patient that this is being done.

If, however, the weight falls seriously—let us say, for example, that a patient of 10 stones (140 pounds) loses 6 pounds in as many weeks of treatment—that is an indication of relative overdosage. X-rays should be intermitted for a fortnight, and resumed at not more than 30 r per dose over the whole trunk, and this dose should again be halved if weight loss continues.

In the case of patients who show extreme sensitivity from the start, that is those who have distinct nausea from a single dose on the upper half of the trunk, it may be necessary to cut the dose to 10 r per week. Patients who would previously have been given up as unsuitable subjects for x-ray treatment are now treated successfully by these very small doses.

### *Saturation symptoms*

Scott was of the opinion that all patients with spondylitis



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should show symptoms of mild saturation at the end of a course, if these symptoms did not seem to be appearing after half a dozen sittings, he would raise the weekly dosage to 80 r or 100 r

Definite saturation is always associated with a raised blood sedimentation rate, in other words, it represents a negative phase, similar to that which takes place in vaccine therapy pushed to the stage of reaction. It has long been the practice in the Charterhouse Rheumatism Clinic to avoid such reactions, and to reduce dosage when there is loss of weight, even though the patient makes no complaint. I am in some doubt as to whether saturation, indicated by mild x ray nausea and loss of appetite, is something to be deliberately aimed at. If mild, it is certainly harmless, and the patient recovers from it in a few weeks, any slight loss of weight being more than made good.

### *Stimulation of resistance*

The object of the treatment is to stimulate resistance. Is resistance ultimately more effectively stimulated if it is first slightly depressed? (That it is depressed is shown clinically at times by an exacerbation of spondylitic pain.) It may be so. But I advise all who essay the treatment of spondylitis for the first time not to exceed 60 r per week on the whole body, even if no x ray symptoms are produced. After they have gained experience, they can decide the matter for themselves. I will confine myself to saying that excellent results have in many cases been obtained without patients experiencing any discomfort whatever. On the contrary, they gain weight, feel more energetic and experience less pain, even while the treatment is in progress.

### *Indications for small dosage*

If it is possible for a patient to attend twice a week so that the weekly dose of 60 r may be divided into two doses, he is much less likely to develop any x-ray nausea. The twice-weekly dose of 30 r should be used whenever possible.

Let no one think that such small doses are therapeutically inactive. They are, for instance, capable of causing regression in carcinoma of the breast to an extent which may make an inoperable tumour operable, and, in cases of severe leukaemia, it may be necessary to use initial doses of only 5 r.

### *Indications for larger doses*

There are, of course, individuals with spondylitis who require doses above the average. If, with a dosage of 60 r each week

nothing good or bad has happened after 6 or 7 sittings, it is permissible to increase dosage, or, which is better, to give the same dose twice a week

Cases may arise in which a patient has only a limited time available to receive treatment. Unless he proves unduly sensitive, one may try to crowd the dosage into a matter of 6 weeks, giving 60 r twice a week. This is likely to produce more nausea, but is not dangerous in suitable cases. The patient may, however, seem to himself to be definitely worse at the end of the course than he was at the beginning, and should be warned in advance of this possibility.

The real effect of any course, however, cannot be estimated until at least 2 months have elapsed since the last x-ray treatment. If there has been a marked negative phase, it may take a month for the patient to recover. He should then make rapid improvement and lose most or all of his pain during the second month.

### **Repetition of the course of treatment**

We now come to the question of a second course. Should a second course be given, and, if so, when?

Scott was of the opinion that 2 or 3 courses should be given, even if all the symptoms vanished, and that saturation should be arrived at in each course.

It is necessary to consider three possibilities in regard to a patient's condition 3 months after the completion of a course: (1) He may be completely free from symptoms. (2) his symptoms may be less, but still present in some degree. or (3) he may be no better, perhaps even worse. Fortunately, the great majority of cases can be classified under the first two headings.

### *Procedure when patient is free from symptoms*

When a patient is symptom-free and has put on weight, my personal opinion is that he should have a second course, but not of such a nature as to cause any detectable upset.

If the first course produced no negative phase, it may be repeated. If there were signs of saturation, dosage in the second course should be reduced. Unless the saturation has been severe, which means that the wrong dosage has been administered, a reduction of 25 per cent is usually sufficient to avoid all x-ray symptoms. That is, 45 r, instead of 60 r per week in an average case. We are now dealing with an apparently healthy individual, and should remember the sound medical principle, *nil nocere*.

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It may be asked, why give a second course at all? The answer is, of course, that spondylitis is a treacherous disease, and that absence of symptoms is no guarantee of cure. It is, however, a fact that many patients treated in the pre spondylitic stage lose all their symptoms after a single course, and are thereafter well for many years. Not a few have gone through long periods of active service without developing any trouble. This cannot, however, be looked upon as a rule. We must usually expect a relapse, sooner or later. I should not like to say that we can be certain of preventing relapse no matter how many courses we give, but it is a wise precaution to give at least 2 further courses, the first after 3 months, the second after 6 months, counting in each case from the date of the last sitting. Provided we keep the dosage below the point at which it produces any x-ray symptoms, at least we can do no harm.

The cynic may add, "nor any good, either." The same jibe has been made in the case of vaccine, gold and other agents in doses too small to produce any toxic symptoms, but clinical observation and biochemical tests prove that beneficial effects may be produced without any preliminary disturbance.

### *Procedure when patient shows lessening of symptoms*

When the patient is improved at the end of 3 months, but still has some pain, the case should be reviewed *de novo*. A fresh search must be made for a possible concealed septic focus which, though not the actual cause of the spondylitis, may be interfering with normal x ray effects. Haemoglobin, white-cell count and blood sedimentation rate must all be rechecked. The patient's general circumstances must be reviewed, and his mental reactions investigated. Only when all this has been done, and when anything found to be wrong has been so far as possible rectified, should further x ray therapy be prescribed.

To settle the dosage for the second course in such a case is not an easy matter. The patient may merely be in need of a repeat course or the dosage may have been too little or too much. It is safer to assume the latter, unless there were absolutely no signs of saturation. The course should be repeated, less 20 per cent, and, if possible, the weekly dose should be divided into two sittings.

In such circumstances the second course will usually produce further improvement or complete relief of symptoms. A further

course in 3 months should be given, and what one hopes may be a final one should be given after another 6 months

If the second modified course has not the desired result after 3 months, sharper measures may be tried, 200 r being given once a week until very definite x-ray sickness is produced, provided this can be brought about by not more than 5 such doses. I do not, however, advise the inexperienced to try this. It does not always work, and the patient may take some time to recover from the effects of the remedy. It is better to resort, for a time at least, to some of the non-radioactive forms of treatment described later in this book.

### *Procedure when patient shows no improvement*

Finally, we have the patient who, 3 months after his last x-ray treatment, is no better, but perhaps worse.

The first question to settle is whether or not there was any improvement at any point during the course—an improvement subsequently lost. I digress here to say that the patient's subjective account of his symptoms should be carefully recorded week by week. If it is not possible for the physician to do this, the assistant actually carrying out the x-ray treatment should be instructed to make notes, and it is essential that the physician himself should see the patient at least once in every 3 weeks. If a patient declares himself much better after 4 or 5 treatments, and subsequently relapses, it may be an indication that, for him, the dosage is too high. But this improvement is not in itself a reason for modifying the course in the absence of early signs of saturation. If, however, this history is given when the ultimate result is poor, it must be taken into account. In such a case one may try again after 3 months with smaller doses.

But let us assume that there has been no improvement at all. Then all that was said about re-investigating cases in which pain has diminished but not gone holds good, and is even more necessary.

### **Causes of failure to respond to treatment**

#### *Septic focus*

It must be emphasized that teeth and tonsils are not the only foci of concealed sepsis. Infected sinuses are not uncommon. A clinical examination by an aurist, including transillumination, is not always sufficient to exclude sinus trouble. Recently a patient

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of mine who had been so examined and passed as normal was later shown by radiological examination to have a shadowed antrum, which proved to be infected

Then there is chronic appendicitis. This may occur without the patient having any suspicion of it. The only symptoms may be indigestion. The area tender to pressure may be very limited in such cases, and may be easily missed by ordinary palpation. Nor is routine x ray examination always capable of excluding it. If, with proper technique, radiography fails to visualize the appendix on two separate occasions, this raises a strong suspicion that the appendicular lumen is blocked, even if it is visualized in a film, a normal-appearing appendix is not necessarily healthy. Unless it is both visualized on the screen and palpated by the radiologist, chronic inflammation cannot be excluded.

It is well also to remember that a chronic appendix may result in a tender area above the right iliac crest, near the spine, and thus give rise to a suspicion of spinal trouble.

The older physicians laid perhaps more stress than we do today on intestinal fermentation as a cause of rheumatic pain. Certainly, a dose of castor oil in a case of acute lumbago or of "stiff neck" sometimes works wonders. I recall one woman patient, not more than 30 years of age, with whom one could do nothing until it was discovered by an opaque meal that her caecum was bound down in the pelvis, and contained a permanent "septic pool". She was operated on and shortly recovered her health permanently.

The prostate must be remembered, and the bladder, also infection of the gall-bladder must be borne in mind, though this is, of course, rare in young people.

### *Sociological causes*

Sometimes the cause of failure lies in the mind of the patient. Disgruntlement with his job, an unhappy love affair, an unsatisfactory marriage, any of these may result in failure of treatment.

### *Other forms of treatment*

If no sufficient cause, physical or mental, can be found, some other method of treatment should be tried.

What should this method be? I will say at once that, apart from laboratory aid to which I shall presently refer we can only "try and see". Vaccine therapy is the most likely to help, if this fails, then small doses of gold sulphide should be administered. Occasionally, bismuth sodium tartrate is effective, as is radioactive thorium X.

**Red-cell sedimentation rate test**

As this book is intended for those who may not have special laboratory assistance at hand, I have laid stress on the clinical observation of the patient. Fortunately, in nine cases out of ten this suffices, especially if use is made of the red-cell sedimentation rate, a test which is likely to be available wherever there are x-ray facilities. The blood sedimentation rate may be normal or minus in the early part of stage I. Later, corresponding with the "rosary" appearance in the sacro-iliac joints, it is raised. It should always be checked before x-ray treatment is commenced. A small increase during a course is to be looked for, and if any marked x-ray symptoms develop towards the end the blood sedimentation rate may rise considerably. In my opinion this should be avoided, but it is not in any way dangerous, and there will be a rebound to a normal or less abnormal rate within a few weeks. In a few cases this does not take place, and, as a rule, in such instances there is no clinical improvement. When the blood sedimentation rate is lowered satisfactorily, but the patient says he is no better, mental disturbances should be especially looked for.

**Differential sedimentation test**

There is another biochemical test, known as the differential sedimentation test which gives more information than does the blood sedimentation rate. Unfortunately it is at present available at a few places only. The method was first introduced by Bendien (1931), and modified by Lowe (1933) and Coke (1933). Coke (1937) described the rationale and technique of the procedure very fully and he says in a recent paper (Coke, 1947) that he has not essentially modified the method since that date. Those interested should consult the original account, here I can only refer to the main principles.

Instead of observing the sedimentation of red cells, orthovanadic acid is added to serum. A flocculate or precipitate occurs. The normal amount of this precipitate has been determined by experiment. It has been found that, in a wide range of pathological conditions, the precipitate varies in very much the same way and in the same degree as does the rate of sedimentation in the ordinary blood sedimentation rate (Fig. 20). This part of the test (which can be carried out on serum) may, therefore, be used as a substitute for the blood sedimentation rate, but is said to be more accurate, as the amount of precipitate is estimated optically by a very delicate instrument known as an interferometer.

## X-RAY TREATMENT

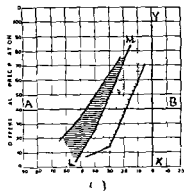
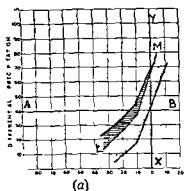
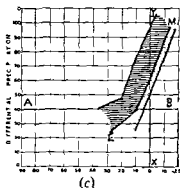


FIG 20—DIFFERENTIAL SEDIMENTATION CHARTS

(a) *Normal* The graph LM represents precipitation in unheated serum and crosses the horizontal line AB within 10 points to the left of vertical line XY. This corresponds with a normal blood sedimentation rate reading. On the right is the graph made after heating serum. Dotted space between = green field. On left is the graph made after heating serum with ether. Lined space between = red field. Both normal in size and shape.

(b) *Spondylitis early stage II* The graph LM (untreated serum) is 34 points to the left of the vertical line XY. This corresponds with a high blood sedimentation rate. The red field (ether effect) is slightly enlarged. The green field (heating effect) is much extended. This indicates a high resistance and is of favourable import.

(c) *Spondylitis stage III* The graph LM (untreated serum) is normal, as in (a). Blood sedimentation rate is also normal. Patient for the time being without symptoms. The red field (ether effect or toxicity factor) is however greatly enlarged and the green field (heating effect or resistance factor) is shrunken. Thus the differential sedimentation test indicates that an exacerbation is likely to occur.



If a second specimen of the same serum is heated for half an hour at  $56^{\circ}\text{C}$ , and is then dealt with in the same way by adding vanadic acid, the amount of precipitate is less than with the unheated serum. For normal sera the amount of difference is sufficiently consistent to enable a norm to be charted. Several observations are made with standard vanadium solutions at definite degrees of acidity (pH) both with the unheated and the heated serum. These results are plotted on a chart having the

usual ordinates and abscissae. The chart is divided into empirical units which, by experience, have been found to be convenient.

The fixed horizontal line in the chart and the fixed ordinate are of special importance. The plotted curve for unheated normal serum cuts the horizontal line somewhere between 0 and 10 to the left. For heated normal serum the curve cuts the horizontal line between 14 and 18 units to the right of that obtained from unheated serum.

If, instead of being heated, a third portion of the same normal serum is shaken with ether, and the plotting is repeated, an opposite effect is produced. The curve now obtained cuts the horizontal line to the left of the original curve. The shift is 12–18 units.

### *Red and green fields*

We now have a chart with three curves cutting the horizontal line, (1) from unheated serum, (2) from serum heated to  $56^{\circ}\text{C}$ , (3) from serum shaken with ether. It has been found helpful, as originally suggested by Scott, to fill in the spaces between the curves with different colours, to the right with green, and to the left with red. That is green=heating effect, red=ether effect. A study of the exact measurements of the fields, above and below the horizontal line, also yields valuable information, but to discuss this is beyond the scope of this work.

### *Clinical use*

Now for the clinical applications. The central curve gives us the same information that we get from the blood sedimentation rate. In conditions in which the blood sedimentation rate is raised, the point where this curve cuts the horizontal line is shifted to the left in varying degree.

But the differential test gives us information which the simple blood sedimentation rate cannot give. For instance, with the same degree of shift to the left, the size and relationships of the red and green fields may be quite different. A large green field indicates a high resistance, a large red field indicates that the detoxicating mechanism of the body is failing, or is about to fail.

I must emphasize that this test is not in any way specific. A large green field is a measure of general non-specific resistance only, it has nothing to do with such matters as, let us say, the temporary immunity obtained by antityphoid inoculation, or the natural immunity conferred by an attack of measles. It is especially useful in diseases in which the aetiology is more or less obscure,



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as it is unfortunately in diseases in the so-called rheumatic group, including spondylitis

In the treatment of spondylitis, all that we can do at present is to stimulate natural resistance, in other words, to induce artificially a state of affairs which brings about spontaneous cure or long remissions

Although it is not possible to diagnose spondylitis from the inspection of a differential sedimentation test chart, yet, given a known case of spondylitis, it is possible to state with a considerable degree of accuracy whether the patient is in the earlier or later stages of the disease

In the former, corresponding with definite sacro-ilitis, there is a shift to the left, that is, a raised sedimentation rate, a normal red field, and an enlarged green field. The picture is that of any subacute infective condition

In stage III—that of ankylosis and deformity—the picture is entirely altered. The shift to the left is now small, and the blood sedimentation rate alone would tell us practically nothing, or even mislead us into thinking all was well. But the differential test shows a vastly increased red field and a green field much less than normal, indicating a severe metabolic disturbance

While the appearances in stage III are of extreme scientific interest, they are not of much clinical value. The damage is done, and we can do little to help by any non surgical form of treatment. But in stage I, where wide-field x ray treatment is of the most use, the size of the green field is of great importance. It is possible to "knock it out" by overdosage and it must always be remembered that overdosage is a relative term. The physician who can check his dosage every few weeks by the differential sedimentation test is unlikely to run into any serious trouble. Fortunately, there is a considerable correspondence between the readings of the ordinary blood sedimentation rate and the behaviour of the green field. The rate will, of course, be abnormally high when we start treatment, and we may expect it to rise a little further towards the end of a course, but any marked jump is a danger signal

I realize that for the great majority of those who may employ x-ray treatment in spondylitis the differential test is not available, and as it depends upon an instrument—the interferometer—which is very hard to obtain under present conditions, its use is not likely to spread rapidly. There are many other possible ways of doing this test but none is equal in precision to interferometer readings

My object has been rather to emphasize that a method does exist by which accurate control of dosage may be secured, and to recommend that the ordinary blood sedimentation rate be employed regularly as a second best

For the benefit of those learned in the matter of biochemistry, I quote a few paragraphs from a recent paper by Coke (1947)

The test depends essentially upon drawing a curve of the initial stages of precipitation of serum proteins on the acid side of the iso-electric point. A graph is delineated by plotting the quantity of protein precipitated against the pH of the precipitating agent. The agent commonly used is ortho-vanadic acid in a buffered acetic acid sodium acetate mixture, but both molybdic and tungstic acids may be used. The position of the curve may be shifted both by (a) a preliminary heat denaturation of the serum, and (b) preliminary ether extraction or denaturation of the serum, and the degree of shift as a result of these operations, referred to as the heating-effect and ether-effect respectively.

The initial point of sedimentation on the pH scale is referred to as the *serum sedimentation value* and is essentially identical with the erythrocyte sedimentation rate, and a normogram refers the pH figures to an empirical set based upon figures comparable with those obtained with the ESR. The normal heating effect is between 15 and 20 units. The ether effect is known as the toxicity factor, and should normally be less than 20 units. States of toxicity increase this.

Coke goes on to cite overdosage by gold as a cause of increase in the size of the red field (toxicity factor). Overdosage by x-rays or thorium X may have an equally bad effect. I shall refer later to the use of the differential sedimentation test in connexion with the treatment of spondylitis with remedies other than x-rays.

#### Wide-field treatment by diagnostic apparatus

Many patients treated during the past 17 years have gone to remote parts of the world, hundreds of miles away from any large centre. Every now and then I get a letter from some doctor in Africa, or South America, or some equally distant spot saying that so-and-so has consulted him for spondylitic pain. The letter states that 5 or 10 years ago the patient, according to his own account, was "cured" by x-rays, and wants to have the same treatment again, but this is, for practical reasons, almost impossible. What should be done?

Now, in these days, few places are so out of touch with the world that they have no facilities for x-ray diagnosis. The small set, giving 30 milliamperes at 85-90 kilovolts is almost universally distributed, and in the majority of cases facilities exist for screening. This means that a tube capable of running for 10 minutes at

## X-RAY TREATMENT

2 milliamperes without damage is available. With such equipment wide-field treatment can be carried out quite well.

### *Technique*

The technique previously described needs only slight modification. We assume that no dosimeter is at hand, so that one must resort to the older method of gauging dosage by milliamperage, filtration, kilovoltage, distance and time. I recommend 2 milliamperes, 3 millimetres of aluminium, 85–90 kilovolts, 50 centimetres anticathode skin distance and 10 minute exposures. The radiation falling on the skin is certainly much less than 60 r per sitting—it is, in fact, of the order of 20–25 r—but is usually effective, though courses may need to be longer. Variation from this technique must be adjusted to clinical results. Saturation signs will occur only in sensitive subjects. The question may be asked, does our standard technique as earlier described still err on the side of overdosage? It may indeed be that less would accomplish as much, but patients are not guinea pigs, and in a busy department it is not easy to depart from a well established procedure which, on the whole, gives excellent results—results good enough, at any rate to have impressed the medical world with a belief in the value of x rays in the treatment of spondylitis.

If anyone using a diagnostic set for wide field wishes to increase dosage, I suggest that it would be better to have more frequent sittings, say, twice a week rather than to try to increase the intensity of the individual exposures.

### **Theoretical dangers of wide-field x-ray therapy**

Scott (1939) records that in 1920–21 he decided to try the effect of subjecting the whole body to small frequent doses of medium-voltage x rays as a prophylactic measure against generalized metastases after operation for breast cancer. Fifty cases were treated, and kept under constant observation for one year. Careful blood records were taken, as there seemed reason to fear that such widespread and prolonged exposure to x rays might cause pathological changes. The risk was considered to be justified however, by reason of the fact that most of the patients would die ultimately from secondary malignant invasion if nothing were done. At the end of a year, however, so far from any ill effect being observed, every case showed an all round improvement in general health. The pathologist who kept the records of the blood examinations was much impressed, not to say puzzled, by this

result. There was no alteration for the worse in the blood picture of any patient in the whole 50 treated.

I saw half a dozen of these patients at the Royal Society of Medicine in 1921, a decade before I became associated with Scott. I very well remember that their whole bodies were bronzed as if they had had a long holiday at the seaside. It may be that this bronzing had something to do with their immunity from any ill effects. I spoke to them all, and they were unanimous in saying that they felt extremely well.

I quote this record because wide-field therapy has been decried in certain quarters as dangerous, on account of possible effects on the blood. In the treatment of spondylitis it is fortunately not necessary to give anything like the dosage administered in this rather drastic experiment, but if these patients took no harm, then *a fortiori* it is unlikely that persons receiving perhaps one-tenth of such dosage in a year would be injured. Scott's experience with wide-field x-ray therapy in spondylitis, plus my own, must be of well over 1,000 cases, and I have never heard of any damage to the blood from x-rays so used.

#### *Effect on the skin*

Provided a 3-millimetre filter of aluminium is used, there are never any signs of skin irritation. A single course causes no visible change in the appearance of the skin. Further treatment may result in very slight browning.

It is, of course, well known that damage to the skin may not show itself for many years. A radiologist of my acquaintance retired after 20 years of x-ray diagnostic work, involving much screening and palpation. He had always been careful about wearing gloves, and congratulated himself on having escaped any injury to his hands. They remained normal for 6 years, and he then developed a typical crop of x-ray warts, which he got rid of only after a long sea voyage. Such cases are, however, exceptional. I am in touch with many patients with spondylitis who were treated 10–15 years ago, and none reports any skin trouble.

All the above refers to patients treated by the wide-field technique which I have described. Whether or not any trouble will develop with the more intensive methods used in the last 3–4 years remains to be seen.

### 5 X-RAY TREATMENT OF PATIENTS IN STAGE II

Stage I in spondylitis is well defined. There are no spinal symptoms but the sacro-iliac joints show characteristic changes.

Once spinal symptoms occur the disease is said to have entered the second stage. But it must be realized that division into stages now becomes somewhat artificial, and that no hard and fast line can be drawn between stage II and stage III. If, however, we visualize stage II as that which presents no obvious deformity, and which, if arrested, leaves the patient with little or no permanent disability, we shall find the classification of practical use. It must also be remembered that in quite a number of cases no clinical history of anything resembling a pre spondylitic stage can be elicited. They are already in stage II when first seen.

### Deep x-ray therapy

In discussing the x-ray treatment of this stage, we must not forget that Scott used practically the same technique as for stage I, and was very successful. But the fact remains that most radiologists in Great Britain, when somewhat belatedly they began to use x-rays in this disease, used a method which was anathema to Scott, namely, high-voltage x-rays intensively applied.

The first paper on this method was, so far as I know, that by Mrs. Hilton, radiotherapist to University College Hospital. She described at the Royal Society of Medicine the method used, which consisted in treating the spine in three sections, and also, separately, each sacro iliac joint area (Hilton, 1943). Each area was given 200 r for 5 days and the whole treatment occupied 5 weeks. She claimed a degree of recovery from deformity which I had seldom seen with wide-field methods, so I asked to be allowed to visit her clinic. She very courteously allowed me to do this, and I saw and talked with many of her patients. They did not, according to their own accounts, seem to have suffered seriously from x-ray toxæmia, and in several cases the increase in mobility of the dorsal and cervical spine was striking.

We had at that time no deep x-ray apparatus at the Charterhouse Rheumatism Clinic, and no place where one could be safely installed. However, an annexe was secured and a unit installed with properly protected cubicles.

### Technique

The technique finally adopted for a full course was very much the same as that used at the University College Hospital, namely, 1,000 r to each of 4 areas of the spine. The area of the aperture of the extension cone at skin level is 4 inches  $\times$  7 inches, kilovoltage 170-180, filter  $\frac{1}{2}$  millimetre of copper and 1 millimetre of aluminum. For the sacral area the aperture is increased to 7 inches  $\times$  7 inches.

We begin with the cervical area (area I) because it has the least constitutional effect, and seldom causes upset. Next, area II is treated. If anything more than slight nausea develops, the rest of the course is modified. The irradiation of the other two areas is almost certain to result in some general disturbance, but there is often relief of spinal pain by the end of the course, and, in most cases, maximal relief within months of finishing the course.

The green field of the differential sedimentation test is less at the end of a course, but ultimately becomes larger than before.

The full course is not administered to weakly patients, nor to anyone whose haemoglobin percentage is less than 90. Nor is it given to any patient who cannot be induced to give up work during treatment and for some weeks afterwards.

If a patient must remain at work, deep therapy may still be used. In this case, the course is the same, but only 2 exposures each week are given, and thus the treatment extends over a period of 10 weeks.

#### *Dangers of the deep therapy method*

Indiscriminate use of the method may make a patient really ill, and this illness may last for months. I have had many patients in whom, even 6 months later, the sedimentation rate was extremely high, and the green field almost absent. Such patients are hard to deal with in their clinical aspects, but still more so on the psychical side. Some conceive such a terror of x rays that it is difficult to persuade them to have further radiation treatment of any sort, and, indeed, until they have been improved by other means such further treatment should not be considered.

#### *Repetition of the course of treatment*

In my opinion the course should not be repeated for cases in which there is no deformity in which all symptoms have vanished, and in which sedimentation tests give a normal reading.

It is not possible—at least, so my experience leads me to believe—to secure a stage II patient against recurrence by any form of treatment we at present possess. Therefore, in the case of apparently well patients who can be kept under observation, I give no further x-ray treatment unless and until there is a return of symptoms. It is true that in discussing wide field treatment I recommended two further courses, but the constitutional disturbance is less with wide-field, and in stage I there is some prospect of helping Nature to eradicate the disease.

An exception to the rule against repeating an intensive course when there are no symptoms is in the case of a patient, well for a year or two, who returns for consultation not with any complaint of relapse, but because he is going abroad to some remote spot. A modified course, of about half the former intensity, may be given as a precautionary measure.

There may be some authorities who hold that if x ray treatment is pushed sufficiently, the disease can be eradicated and that unpleasant side effects should not be seriously considered. But I strongly advise those as yet unfamiliar with the use of x rays in the treatment of spondylitis to assume that whatever dosage they give they cannot be sure of "killing the disease." They should wait until someone publishes statistics gathered over many years, to prove that this can be done.

## 6 X-RAY TREATMENT OF PATIENTS IN STAGE III

This stage is characterized by the presence of actual deformity. X ray examination of the spine will show whether or not there is actual calcification of ligaments. If the ankylosis is merely fibrous, it may be possible to get striking improvement by manipulation, this is greatly facilitated by previous heavy x ray treatment of the part effected. Up to 1,200 r may be given in a fortnight on a single area of the spine. The resolving effect of x rays on pathological fibrous tissue is, of course, well known.

### Hips

In examining a patient with a spondylitic stoop we must be careful to differentiate between genuine kyphosis and a bending forward caused by spasm of the flexors of the thigh. X ray examination of the hip, when this spasm is present, will usually show some loss of articular cartilage in the joint. In short, a condition which, if not checked, will proceed to genuine ankylosis of the hip. In its earlier stages the process can be checked by local x-ray treatment of the parts concerned.

The recommended dosage is 150 r twice a week. If there is much local reaction, however, this dosage may be reduced. After half a dozen sittings we may expedite matters by injecting procaine into the hip. This usually abolishes spasm, and allows us to put the hip through a full range of movement. This is described in detail later on, it should not be attempted until any x ray reaction has subsided.

If it is not possible by these means to obtain good passive movement, then the case is already one for the surgeon.

**Pain**

A patient whose spine and hips are rigid may or may not suffer from pain. If there is static deformity and no pain, x-rays have no place in the treatment. If the patient complains of pain, any of the usual methods of treatment such as vaccine or gold, may serve to palliate it, and x-rays also have their place. But it is quite unjustifiable to "push" x-rays under such circumstances, they will work in moderate doses or not at all.

Pain in deformed patients may be due to continuing activity of the disease, even though it may have already done its worst as regards the ankylosed joints. In such a case it may be relieved by constitutional treatment. It may also be caused mechanically by the distortion of the bony framework of the body, and consequent undue strain in certain muscles. In such a case the pain may disappear after surgical restorative procedures such as arthroplasty. But if the pain is due to persisting activity of the disease, it will not be banished by surgery, and the patient will still have to seek medical help even when his movements have been surgically restored.

**7 SUMMARY****Stage I**

Wide-field therapy is the most suitable for this stage. The dosage should be 60 r per week, the whole trunk being exposed to this dose at one sitting, kilovoltage 130, filtration by 3 millimetres of aluminium. The course should consist in treatment once a week for 12 weeks. This course is suitable for the average patient, but may be modified if necessary according to clinical observations and in the light of sedimentation tests.

Radiologists who may not like to use wide-field therapy may use intensive treatment as described for stage II, provided that they take special precautions to make initial tests of the sensitivity of the patient to x-rays. If this point is kept in mind it is not of prime importance that a particular method should be used. The vital matter is that trouble should be diagnosed before spinal symptoms appear, and that the patient should receive an x-ray dosage adapted to him as an individual. Whatever the method, severe reactions must be avoided.

In the case of females receiving intensive treatment the dosage on the lower half of the trunk should be reduced by two-thirds. This is because of possible damage to the ovaries. If we use the wide-field technique, it is not necessary to consider this aspect,



## X-RAY TREATMENT

some slight irregularity of the menstrual periods being the most that can happen. If the periods are already irregular, excessive or painful, the patient may be much benefited, and even permanently relieved.

### Stage II

In cases in which spinal symptoms are present, the intensive method is the one of choice. This consists in the division of the spine into 4 areas, with a daily dose of 200 r on each area, to a total of 1,000 r. That is, a total dose of 4,000 r divided between the 4 areas in a period of 4 weeks, at a kilovoltage of 170–180, with a filter of  $\frac{1}{2}$  millimetre of copper plus 1 millimetre of aluminium on the patient's side. There is no objection to a somewhat higher voltage and heavier filtration. There is nothing sacrosanct about the techniques described. Professor Davison advocates a week's treatment during which 450 r is given to every part of the spine, he repeats this in 3 months. He warns emphatically against overdosage.

In the case of females, it may be considered that the seriousness of the condition justifies a full dose despite the risk of ovarian disturbance. Where young married women are concerned, if the full dose is given, they should be warned against becoming pregnant for several months, or at least till any menstrual disturbance caused by the treatment has cleared up.

### Stage III

No rules can be laid down for treatment in this stage. The object may be merely to relieve pain, or it may be used as an aid to secure more mobility in a particular part.

In stage I we hope to abort the disease. In stage II we aim at preventing actual deformity and producing long remissions. In some instances these remissions may be so long (10–15 years) as to suggest a cure. But in stage III the damage is already done, and radiotherapy steps down from first place to yield precedence to surgery.

## 8 CONCLUSION

This concludes what I have to say of x-ray treatment as such. In stage I radiotherapy almost fills the therapeutic picture. In stages II and III this is by no means the case. I propose to deal with other remedies *per se* in the same manner as I have dealt with x rays, but, fortunately, none of the others requires so long a discussion.

## ANKYLOSING SPONDYLITIS—PART I

Finally, I shall attempt to describe how some or all of these various remedial agents may be combined in the management of an individual case

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## CHAPTER 7

### VACCINES

TREATMENT by antigens from dead microbes is usually spoken of as vaccine therapy. The term is not felicitous, deriving as it does from Jenner's work with a live virus attenuated in malignity by passage through a cow. A vaccine, as the term is now used, means a suspension of killed organisms in normal saline solution or other fluid. The organisms are grown on suitable media, and the number per millilitre is estimated. The master vaccine is then diluted to a suitable strength for the particular purpose intended.

Autogenous vaccines are prepared from the patient himself—from a boil, if he has furunculosis, from the sinuses of the skull, if there is infection in this quarter, and so on. Patients with spondylitis may, for individual reasons, require autogenous vaccines. But we are not concerned with these vaccines in the general treatment of spondylitis, because no one knows the causative organism.

Stock vaccines are made on a kind of "blunderbuss" principle, and are dignified by the high sounding but hybrid word, polyvalent. This means that a large number of pathological strains are blended in the hope that among them will be one or more capable of provoking the desired antibody response. The usual method of grading the strength of a vaccine is to state that it contains so many million, or fraction of a million, dead bacilli in each millilitre. The vaccine may be polyvalent as to staphylococci alone or as to streptococci, or it may be a mixture of both.

It must be said at once that the use of polyvalent mixed vaccines in spondylitis is purely empirical. No wholly satisfactory explanation as to why they should relieve spondylitic pain has ever been offered. But the fact is that they do, not always of course, but certainly in a high proportion of cases.

There is nothing mysterious in the preparation of vaccines at the Charterhouse Rheumatism Clinic. The technical details have been published by Warren Crowe, and are available to anyone interested. Stress is laid upon the use of fresh cultures, upon a wide mixture of strains, and upon maturation, that is, the almost complete disintegration of the bacterial bodies, with the passage of their antigens into solution. Reactions may be produced by

them in concentrations as low as 0·00001 million organisms per millilitre. This means 10 bacteria. Fine filtration does not effect their potency. They are therefore to be regarded as solutions of antigen. Grading by fractions of a million of bacteria is therefore not very appropriate, and some system of antigen units may eventually take its place. Meanwhile, however, it is necessary to use the existing system.

Although my own experience is built largely on the stock vaccine at the Charterhouse Rheumatism Clinic, there is no reason why the polyvalent anti-rheumatic vaccines dispensed by various commercial drug houses should not be similarly used. It should be remembered, however, that some of these contain only streptococci, whereas the Charterhouse vaccine contains staphylococci as well. Also, somewhat larger doses are likely to be necessary to produce the same result. In the case of the anti-rheumatic vaccine dispensed by Parke, Davis & Co. the ratio appears to be about 5 to 1 as opposed to Charterhouse vaccines. That is to say, when a dose of 0·02 million is effective in the case of the latter, 0·1 million will give a similar result when the vaccine manufactured by Parke, Davis & Co. is employed.

Other polyvalent stock vaccines may require a different proportion, but if the principles of vaccine dosage, which I am about to quote, are followed, the proper dose of any vaccine in a case of spondylitis can be ascertained.

### **Clinical reactions to vaccine therapy**

In the early days of vaccine therapy, of which Sir Almroth Wright was then the great exponent, we used to hear a great deal about the opsonic index. Diagrams were published, showing how this was unfavourably affected for a day or two after a vaccine injection and then rose sharply for a varying period. This preliminary fall was associated with a temporary clinical worsening, which was known as the reaction.

It was for long assumed that this reaction was an essential part of the treatment. Warren Crowe showed that, so far as the use of vaccines in the treatment of rheumatism was concerned, this reaction was not only unnecessary, but could be harmful. In rheumatic disorders, the best results are obtained without preliminary disturbance, and this applies also to spondylitis.

There are three kinds of reaction: local (at the site of puncture), focal, that is, increase of pain at sites originally complained of, and, general.

*Local reaction*

Local reaction is rare, and usually is due to the piercing of a fascia or to a dirty needle. It is of little consequence.

*Focal reaction*

Exacerbation of pain and increased stiffness occurs within 24-48 hours of injection. This may last hours or days, and is often followed by some improvement. It calls for some reduction in the exciting dose, perhaps to one half or less.

*General reaction*

Lassitude the next day, irritability of temper and giddiness are the usual general reactions. In the case of a really large overdose, malaise, loss of appetite, rise of temperature and headache may occur. In many cases it is necessary to elicit the symptoms by questioning. This should always be done. If a history of these general reactions is given, the next injection should not be more than one-tenth of the exciting dose.

The general reaction may be silent. That is, there may be no change for 2-3 days, followed by improvement in the condition of the patient. With a suitable dose there is response the next day. A lag in response in itself is an indication of overdosage. The strength of the injection should therefore be reduced until there is a quick response.

The dose may be so little in excess of what it should be that it is only after some weeks that we wonder if all is well. Here, the weight check is invaluable. A slow loss of weight calls for an inquiry into dosage.

Vaccines administered in suitable doses given at correct intervals will keep many patients with spondylitis free from pain and will slow down the advance of the disease. They may even seem to arrest it, and occasionally produce long remissions. This, however, is rare in my experience. The chief disadvantage of the administration of vaccines is that the patient tends to relapse in a few weeks if they are withdrawn. They are not, therefore, the treatment of choice.

They have, perhaps, their greatest value in cases which have been overdosed with radiation, and which do not rebound within a month or two. In such patients the blood sedimentation rate remains high, and if the differential sedimentation test is available, it will be found that the green field (resistance indicator) is very small.

## Dosage

In the absence of any known focal sepsis, the trial dose should be of the order of 0.02 million organisms. In practice 0.2 millilitre from a bottle containing 0.1 million per millilitre will suffice. If this dosage produces any focal or general reaction, it must be reduced in accordance with the principles already described. If nothing at all happens, we have to decide to try a less or a greater dose. The former should be the first choice. If this fails, a cautious increase should be tried. In some cases, one cannot get a good subjective result, but if the blood sedimentation rate is found to be moving in the right direction, and the weight is steady or increasing, one should persist for 2 or 3 months to see whether clinical improvement will follow.

Some patients with spondylitis, especially those who have been overdosed with gold, reach a condition in which they seem to have no power of response to vaccines. Though such patients are not necessarily anaemic, a blood transfusion may set them quickly on the right road.

**Case C M.** A games-master (aged 34 years) in a public school, developed spondylitis. For years the disease did not interfere seriously with his activities, then he became aware that his pains were increasing, and that he was developing a kyphosis. He was treated by heavy doses of gold, and became rapidly worse. When I first saw him at the Charterhouse Rheumatism Clinic his neck was rigid, he could not raise his arms above his head, he had difficulty in walking, and suffered agonizing pain from the jolting of a bus or other vehicle.

I treated his condition with small doses of x-rays, but there was no improvement. Then I used vaccines, which seemed equally useless. It was then arranged that he should go into hospital and receive a pint of whole blood. This was done, and 3 days later he was given a small dose of vaccine. This gave him great relief from his pain. After 8 weekly doses he could raise one arm above his head, had some movement in his neck, could walk half a mile without pain, and could ride in buses without discomfort.

Then, by ill luck, he contracted influenza, and was confined to bed for 2 weeks. His spondylitic pain began to return when he got up and went about. Again, vaccine had no effect. The transfusion was repeated, and once more he responded to vaccine.

He went back to his school, and vaccine was sent to the school doctor. He had 12 further injections, at first weekly, and then at longer intervals. Since then (four years), apart from some

established deformity, he has remained fit, and now occupies a very important and arduous post at one of the older universities.

How are we to explain a case like this? In crude language, it would appear that, when first he was seen and given vaccine, there was nothing upon which it could work. In some way the fresh blood supplied this lack, either directly (complement?) or indirectly, by stimulating the reticulo-endothelial system.

Apart from this remarkable response to blood transfusion, the case is noteworthy by reason of the long period of remission which has followed a comparatively small amount of vaccine treatment.

As I have said, cessation of vaccine treatment is usually followed by relapse. Nevertheless, if a pain relieving dose can be found which will keep the patient happy for a fortnight or more at a time, vaccine therapy is the ideal way of treating spondylitis in general practice, for not all patients can regularly attend special clinics. So long as the vaccine is effective it should be given—this may be, with luck, for months at a time. The practitioner can do no harm so long as he does not increase the dose "to see what happens", or push the vaccine because it seems to be losing its effect. Such loss of effect is an indication for a fresh consideration of the case, and probably for a therapeutic rest or a change of treatment.

A suitable test dose is 0.02 million organisms (Charterhouse vaccine) or 0.1 million organisms of anti-rheumatic polyvalent vaccine prepared by Parke, Davis & Co. If these doses are totally without effect, they may be raised ten times. It is not usually desirable to increase them more than this. On the other hand, many cases can take only one tenth of the average dose. But if reaction is produced by 0.002 million (Charterhouse vaccine) it is desirable to look out for some kind of focal sepsis—a septic throat is the most common. A few cases seem very sensitive for no discoverable cause, and may need doses as low as 0.00002 million.

Unlike gold, bismuth and thorium X vaccines may be continued indefinitely so long as they give relief.

### Action of vaccines

The use of vaccines in the treatment of spondylitis is, as I have said, frankly empirical, but of late there have been some attempts to explain their action in terms of allergy and desensitization. Barford (1947) discusses the question at some length. He refers to Urbach's experiments on animals which showed that partial de-allergization results from small repeated doses of specific

antigen, which give rise to a series of "micro-shocks", each insufficient to be clinically perceptible

Ordinarily, in response to infection, some of the antibody produced in the reticulo-endothelial cells is liberated into the blood, and some remains in the cells. In certain cases, however, the antibody remains almost wholly in the cells. If, now, the products of invading micro organisms continue to reach these cells, antigen-antibody reaction occurs and gives rise to the phenomenon known as allergy. Note that it is not necessary for the microbes themselves to reach the reticulo-endothelial cells, hence, a joint which is the seat of allergic reaction may prove, on examination, to be sterile.

In spondylitis, as we do not know the organism concerned—assuming that there is an organism—it is evident that to produce antibodies in the blood, and thus restore normal balance, the more polyvalent the vaccine is the better, because the chance that it contains the specific antigen required is increased. Practical experience has taught us that small doses are often effective in banishing spondylitic pain, whereas large ones cause rapid deterioration. If such pain is a symptom of allergy we can to some extent understand why this should be so.

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## CHAPTER 8

### GOLD, BISMUTH AND ARSENIC

#### 1 GOLD

IN THE treatment of rheumatoid arthritis, gold almost deserves the name of a specific. Almost, but not quite, for there are 30 per cent of complete failures, and relapse is frequent. Nevertheless, the introduction of gold treatment by Forestier in 1930 was undoubtedly the greatest advance yet made in the therapeutics of this very distressing malady.

The relative success of gold in rheumatoid arthritis naturally led to its trial in other forms of rheumatism and particularly in spondylitis, which was at one time regarded as being of a rheumatoid nature. Treatment was given on similar lines, the gold being pushed to the limit of tolerance, and sometimes beyond. The result was disappointing. Patients were only occasionally benefited and were often made worse.

The modern tendency is to give much less gold for rheumatoid arthritis than was commonly administered 10–15 years ago, but it must be remembered that gold made its reputation in spite of injudicious dosage. It cannot, therefore, be argued that the failure of gold therapy to benefit spondylitis was due to this cause, rather it indicated that there was an essential difference between the diseases. Gold soon came to be regarded as of little or no use in the treatment of spondylitis.

Now it is quite true that doses of gold suitable for rheumatoid arthritis are generally useless and can be harmful to patients with spondylitis. But this is very far from saying that gold is of no value in the treatment of spondylitis. The least toxic form of medicinal gold should be chosen, this appears to be colloidal gold sulphide, the toxicity of which is so small that some writers deny it any therapeutic value. Those who have little faith in the effectiveness of colloidal gold sulphide may try doses of 0.001 gramme of Myocrisin (sodium aurothiomalate). Colloidal gold sulphide is certainly not, as a rule, so effective as are other salts in rheumatoid arthritis, but in spondylitis it often has a markedly beneficial effect—and that in doses which are safe even in the hands of the

inexperienced. The initial dose should not exceed 0.5 millilitre of a 0.025 per cent solution, and subsequent doses should never exceed 10 times this amount. In a few sensitive patients, even this very small dose may cause some reaction, but only in the form of a slight increase of pain the next day. For the most part there is no reaction of any kind, but after a few doses pain is relieved.

Not more than 12 weekly doses should be given, after this, one should increase the intervals between doses. A 'holding' dose once a month is often sufficient to keep a patient symptom-free for long periods.

The action of colloidal gold sulphide is, of course, non specific, and, as is the case with all resistance-raising agents, sooner or later the effect is likely to fail. It is particularly useful in the treatment of the many patients who require more or less constant help to keep them reasonably well. I have several who attend once a month, receiving a dose of only 0.5 millilitre of a 0.025 per cent solution of gold sulphide. So long as they do so, they are able to work and play in comfort, but if they allow an extra few weeks to elapse without treatment, then pain returns.

The unbeliever may say that the effect must be psychical only. But dozens of these cases have been checked by the differential sedimentation test, and it has been shown that graphs which have been nearly normal for long periods deteriorate within 3 months if gold is withheld.

Equilibrium may be thus maintained for from 6 to 12 months, when the pains begin to return in spite of the gold. The remedy is not more gold, but some other method of favourably affecting the defence mechanism.

Coke (1947) has shown that failure of gold is accompanied by a degeneration of the differential sedimentation test picture, showing an increasing red field and a decreasing green field. Because vaccines enlarge the green field, whereas thorium X and bismuth may, like gold, reduce it if pushed, vaccine therapy is the logical form of treatment if gold begins to fail. As a rule, vaccines are found, in practice, to be the best alternative; if they fail, no theoretical objections should prevent us from cautiously trying thorium X or bismuth, or even returning to x-rays. But the differential sedimentation test reading warns us to be extremely careful of overdosage.

Gold in the small doses described is not given in the hope of producing long remissions, although occasionally one has a pleasant surprise. The patient attends at longer and longer

intervals, because there has been no pain to remind him to come, and finally he ceases to attend, saying that he no longer feels the need for any treatment

Doses of or below 0.2 millilitre of a 0.25 per cent solution of gold sulphide may be given subcutaneously, larger doses should be injected into the muscles

Gold sulphide administered as I have indicated is not accompanied by any unpleasant side-effects, except in a few specially sensitive individuals. But, for the sake of completeness, I add a list of the symptoms of overdosage. They include stomatitis, skin eruption of an exfoliative type, spasm of the rectum, diarrhoea, renal disturbances and neuralgic pains. Agranulocytosis occasionally occurs, and may be symptomless in its earlier stages, or indicated only by some complaint of lassitude.

In the treatment of spondylitis the urine should be tested for albumin before a course of gold is commenced, and a complete examination of the blood, including the blood sedimentation rate, should be made for the purpose of record. It is not necessary to repeat these tests unless there is clinical regression.

## 2 BISMUTH

The best preparation of bismuth seems to be bismuth sodium tartrate, which was introduced into Great Britain by Dr Percy Hall. He had used this salt in Africa in the treatment of yaws, and had noted that any accompanying rheumatism often improved. He organized a clinic to try out this drug at the Charterhouse Rheumatism Clinic in 1943. I sent to him some 'obstinate' cases of spondylitis, but after a trial of some months he said that the drug did not appear to be of any benefit. So the matter fell into abeyance, until, a year later, it occurred to me that the dosage he was using—1 grain each month—might not be suitable in spondylitis. I then tried one-third grain every 2 weeks and had several successes, as judged by relief of pain.

The drug seems to have the same general therapeutic effects as gold sulphide, but may give relief when gold has failed. I do not give it for more than 6 months at a time, but it may be resumed after 3 months' interval. Given as described above, the drug has no toxic effects. Unfortunately, in some people it causes considerable reaction at the site of the injection. The method which causes least inconvenience is deep injection into the buttock muscles, at a site well above the ischial tuberosity. The discomfort is usually not serious, and passes off in 2 or 3 days. In very sensitive subjects

one-sixth grain may be given once a week a little procaine being added

There are many proprietary brands, Sobita being the best known. At the Charterhouse Rheumatism Clinic bismuth sodium tartrate is put into rubber-capped bottles in our own laboratory and appears to be as efficient as any of the branded products.

Although less useful than thorium X, vaccines or gold bismuth sodium tartrate should nevertheless not be forgotten in the treatment of patients in whom these remedies have failed to relieve spondylitic pain.

### 3 ARSENIC

Thirty or forty years ago arsenic had a great reputation as a remedy for the relief of rheumatoid arthritis. In those days it was classed, with potassium iodide, as an alterant, which meant that these drugs had a beneficial action in no way to be explained by pharmacological experiments.

Arsenic is certainly an effective tonic in some cases of spondylitis. *Nux vomica* and its alkaloids so valuable in most debilitated patients, are generally unsuitable in spondylitis owing to the tendency in this disease to muscular spasm. How much effect arsenic has on spondylitic pain is difficult to assess but the general condition is greatly improved, and ability to bear pain is increased.

The drug should be administered alone in the first place so that its effects may be studied. A useful prescription is 4 minims of Fowler's solution made up to half an ounce with chloroform water, and given 2 or 3 times a day after meals. A glass of milk taken immediately afterwards minimizes irritant effects on the stomach. The dose should be reduced if there is indigestion, diarrhoea or redness of the conjunctiva and medication should not be continued for more than 3 weeks at a time.

If indigestion is the only symptom the drug may be injected in the form of cacodylates, this diminishes but does not altogether stop, gastric effects, as some arsenic is excreted into the stomach no matter how it is introduced into the system.

Once the tolerance dose has been ascertained arsenic may, if it seems desirable, be combined with iron.

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## CHAPTER 9

### THORIUM X

#### 1 GENERAL CONSIDERATIONS

THE EXHIBITION of thorium X provides us with a method of obtaining the constitutional effects of radiation without any complication caused by possible local action. Certain writers have bracketed gold, bismuth, and thorium X together as heavy metals and speak as if they all acted in much the same way. But in the case of the former two, it is the metal itself which is effective, and overdosage will result in an actual accumulation of the elements in the system, with accompanying symptoms of metallic poisoning. On the other hand, in the preparation of thorium X used for medicinal purposes the amount of metallic thorium is chemically undetectable, and its presence can be demonstrated only by physical means. Therefore, although there may be cumulative toxic effects from overdosage, they are those of excessive radiation, and have nothing to do with metallic poisoning.

Thorium X is a disintegration product of thorium, a radio-active element having an atomic weight of 232.12. From thorium minerals there can be separated an active substance known as radio-thorium, which slowly disintegrates, losing about half its activity in 2 years. Radio thorium is the immediate parent of thorium X, which gives off *alpha* rays only. Thorium X, like radium emanation (radon) has only a very short life, being reduced to half value in less than 4 days. This property makes it eminently suitable for medicinal purposes, as it becomes practically inert in 2 or 3 weeks, and there is consequently no risk of piling up radioactive material in the body. *Alpha* rays, that is atoms of helium, are relatively large particles moving at comparatively low speeds. They have a high ionizing effect but their range is very limited. Theoretically no *alpha* rays should escape from an ordinary glass bottle but anyone who is nervous may wrap the bottle in lead foil. This lack of range is of no consequence when the radio-active material can be brought into close relation with the tissue cells, as happens when a solution of thorium X is injected and absorbed into the circulation.

I began to use thorium X at the Charterhouse Rheumatism Clinic in November, 1944, and naturally consulted the literature.

Apart from papers on its use in skin diseases, I found only one reference, though that was an important contribution. Forestier (1936) spoke with approval of the effect of weekly injections of thorium X in the treatment of spondylitis.

There is, however, an extensive literature concerned with the therapeutic uses of radon, which is the first disintegration product of radium. This has a half-value period of 3.85 days which is almost the same as that of thorium X. It differs, however, in the respect that its radiation does not consist wholly of *alpha* rays, the actual figure being 92 per cent *alpha* rays, and 8 per cent *beta* rays and *gamma* rays. It is soluble to some extent in water, and therefore suitable for exhibition by the mouth. There are, however, technical difficulties regarding its hypodermic administration, and this method has not been much used.

The effects of thorium X, given subcutaneously, seem to be in the main similar to those of radon. This is what one would expect. Those interested in the subject of radon should consult *Emanotherapy* (Humphris and Williams, 1937). They quote many foreign writers as to the use of radon in the treatment of the type of patient who visits or used to visit continental spas. The largest series referred to is that of Happel, who published a detailed analysis of 914 cases. He claimed the following results: good, 37.5 per cent; improved, 37.9 per cent. The above results were obtained by the daily administration of radioactive water *per os*, and the treatment was often continued for months.

As Forestier (1936) had claimed good results in the treatment of spondylitis from weekly injections of thorium X, and as this method was the most convenient to use in a clinic where most patients find a hebdomadal visit as much as they can manage, I decided to adopt this plan. Dosage is measured in electrostatic units (e.s.u.). Each unit represents rather less than half the amount of radiation in equilibrium with 1.07 milligram of radium element. The weekly injection has been 30–100 e.s.u.; this is about the weekly sum of the daily doses of radon given to his rheumatic patients by Happel.

Since 1944 I have treated more than a hundred cases of spondylitis with thorium X. The list includes all stages of the disease, except the pre-spondylitic. At first only those who had failed to obtain relief from other remedies were so treated. Only a very few patients have failed to receive at least temporary benefit, and many are most enthusiastic. "The best treatment I ever had" is a common expression.

In a definite proportion of cases, however, there is a relapse.

very soon after the cessation of treatment. It might be argued that the injections had not been continued for a sufficient time. This may sometimes be the explanation, but there have been a few patients who, after making a brilliant start, relapsed before the projected course was finished. The introduction of thorium X treatment certainly does not render obsolete older and well tried methods, of which x-ray therapy is the most important.

On the other hand, in the case of patients unable for some reason to obtain x-ray treatment, thorium X is the treatment of choice. I quote two such cases in which the thorium X was sent in ampoules and administered, under direction, by a local doctor.

*Case 1*—Mr S W (aged 23 years) Spondylitic symptoms for 5 years. Neck movements very limited. Left thigh permanently abducted by muscular spasm, giving the patient a curious gait. Spine tender on pressure over whole length. General condition poor. Mentally depressed.

The patient lived in a remote part of the country and it was decided to send thorium X to be administered by his local practitioner. He was given 50 e s u per week for a period of 16 weeks.

At the end of this time, improvement was pronounced. Neck movements were more free and pain much less. Walking became easier, and the patient was able to ride a bicycle again and attend to business.

The injections were reduced to 1 in every 2 weeks. After a total of 6 months' treatment walking was almost normal, there had been a gain of 7 pounds in weight and the patient's spirits and self-confidence were so far restored that he took unto himself a wife. Six months later he was still well.

*Case 2*—Mrs M (aged 26 years) First seen 24.5.45. The trouble had started 2½ years before, after a pregnancy. Unfortunately, she had been put in plaster, and the right hip was rigid, the left nearly so. Radiographs showed sacro iliac joints almost sclerosed, and involvement of both hips. Walking was painful, the left thigh was in spasmodic abduction. There was severe kyphosis, and the lumbar curve was obliterated. She was unable to do her own shopping. Her normal weight of 10½ stones had decreased to 9 stones.

Treatment. Between 24.5.45 and 9.8.45 the patient had 12 injections of thorium X, mostly at weekly intervals, and averaging 40 e s u. The patient was now much better, with some increase of movement in left hip, and disappearance of abduction. She could now do some of her own shopping.

Treatment was then altered to 100 e s u every 2 weeks. Three months later she was doing all her own shopping and could walk slowly for some miles without pain. Her weight had increased from 9 stones to 10 stones 8 pounds.

During the next 18 months the patient remained well, but, of course, severely crippled. About this time I had the Smith Petersen vitallium cup operation brought to my notice, and, on my advice,

she consulted Sir Reginald Watson Jones. He suggested an operation on both hips with a view to renewed mobility and also an operation on the spine.

These operations were performed by Sir Reginald Watson Jones and by Mr. Alexander Law with excellent results up to the date of writing. It may be noted here that corrective operations have of course no effect upon the *foons et origo mali* and that the patient remains liable to fresh exacerbations. This patient did in fact experience some recurrence of spondylitic pain but it quickly yielded to a further course of treatment by thorium X.

Why should thorium X sometimes fail as spectacularly as it often succeeds? The answer would appear to be that like all other remedies so far found to be of use in the treatment of spondylitis it achieves results only by stimulating resistance. For this purpose it is as a rule excellent but there are cases when the necessary basis for its action does not seem to exist. Sometimes nothing can be found which will act favourably but in general failure of thorium X does not mean that other agents will necessarily fail. If there is no improvement in 8 weeks on a weekly dose of 50 e.s.u. the dose may be doubled but if at the end of another 4 injections there is still no result this form of treatment should be abandoned.

In cases where there is great activity as instanced by severe pain and a raised blood sedimentation rate great caution should be exercised and dosage should not at first exceed 20 e.s.u. Even this small dose may cause a smart reaction within 48 hours and if this is the case it should be reduced to 10 e.s.u. As the acute phase subsides the dose may be increased.

In the chronic case with no great activity caution is called for if the haemoglobin percentage is below normal and if the white cell count is much under 5 000 per cubic millimetre. This figure would in itself have been regarded some years ago as indicating a leucopenia but is nowadays quoted in books on pathology as within normal limits. In such a case dosage should not exceed 10 e.s.u. each week to begin with but if the blood improves either as a result of this treatment alone or in combination with such drugs as iron and arsenic the dose may be gradually increased.

## 2 DANGERS FOLLOWING THE USE OF THORIUM X

As with other non specific remedial agents a relative overdose may cause exacerbation of the symptoms it is intended to relieve and persistence in such a mistake may as in the case of gold therapy produce a serious and long lasting relapse due to a complete breakdown of resistance.



With a properly adjusted dosage unpleasant effects are absent Thorium X can, however, produce anaemia and leucopenia The onset is insidious, and may occur although from the point of view of spondylitis, the patient is doing very well Provided, however, that a monthly check on the blood is carried out this condition need cause no alarm, an intermission or reduction of thorium X dosage combined with iron and arsenic treatment usually puts matters right In obstinate cases, the addition of intramuscular injections of pyridoxine (vitamin B<sub>6</sub>) will put matters right

In the Charterhouse Rheumatism Clinic, since 1944, many thousands of injections of thorium X have been given not only by me but by other physicians I find that in 4 years about 1 000 000 units have been supplied to the clinic Taking 50 e s u as an average dose, this works out at 20 000 injections patients received an average of 20 injections per annum I could let the previous paragraph stand without further comment, were it not for one case, a case from which the lesson to be learned is, unfortunately, not clear

*Case 3*—Mrs L (aged 33 years) First seen at the Clinic in January 1946 History of vague pains at intervals for the past 11 years Recently these pains had settled in the back There was no obvious deformity Clinically and radiologically she was a case of spondylitis in early stage II A course of local deep x rays to the spine was given which took 10 weeks each of the 4 areas receiving a total of 1 000 r There was but little general disturbance and the pain almost disappeared

In August this patient returned complaining that her pain was again beginning to be troublesome Her blood was examined and she was found to have a haemoglobin percentage of 75 and a white cell count of 5 000 per cubic millimetre Her doctor was informed and asked to prescribe the usual remedies At this time owing to war conditions few people showed a haemoglobin percentage reading of more than 85 or 90 and I did not then consider that thorium X treatment was contra indicated especially as many patients showed an improved blood picture at the end of a course

She received 8 weekly doses of 50 e s u and her spondylitis improved steadily 4 doses of 100 e s u were then given at fortnightly intervals She then ceased to attend saying she felt well and was free from pain her haemoglobin was 67 per cent Her white-cell count was not taken (a bad omission)

The patient was sent back to her doctor as a satisfactory case and he was asked to keep up the treatment of her anaemia In a spondylitic clinic we are used to haemoglobin percentages of 60 and below (even 40 occasionally) in patients applying for treatment, and we find they yield to the usual measures

In January, 1947, she returned complaining of slight pain in the back and that she felt very tired Her blood showed still a haemoglobin percentage of 67, but the white-cell count was only

2,900 per cubic millimetre For the first time, I was alarmed I wrote an urgent letter to her doctor, who called in a local consultant A month later I saw her again The blood readings were practically the same An extensive report was called for, but did not reveal anything to cause any special alarm The patient was still able to do the office job from which she had never been absent

I did not see her again I learned afterwards that 6 weeks later she had been admitted to hospital with a haemoglobin percentage of 40, and a white cell count of 2,200 per cubic millimetre Despite blood transfusions she grew rapidly worse and died within a month The death certificate read "aplastic anaemia"

I said the lessons to be learned from this case were not clear This is not altogether true, for it is obvious that omission to take the white-cell count immediately after the course of thorium X treatment was a serious error But whether it would have made any ultimate difference may be doubted

The difficulty is that she had, on the whole, much less of both x-rays and thorium X than most patients, certainly not half the average

The text-books describe an idiopathic aplastic anaemia Was this such a case, which happened to occur in a patient who was receiving thorium X? One other point did emerge It transpired that for years she had had septic tonsils, which she refused to have removed, as "they did not bother her" I recall the case of a well-known London radiologist who died of aplastic anaemia He was known to have chronic sinus infection, and there was discussion in medical circles as to whether exposure to x-rays was alone responsible for the state of his blood

One thing is certain This case should not be used as an argument against the medical use of thorium X The tragedies due to the early misuse of gold were far more serious than anything which has happened in the case of thorium X, but fortunately the use of gold was not abandoned

Thorium X is far too valuable an agent not only in spondylitis, but in other forms of rheumatism, to be given up because of a single fatality, even if we believe that that fatality was wholly due to it

### 3 CONCLUSION

I suggest as a working rule that thorium X should not be given unless, to start with, the haemoglobin percentage is 90 and the white-cell count at least 5,000 per cubic millimetre Thereafter, there should be a monthly recording, and these figures should not be allowed to fall more than 10 per cent no matter how well the

patient is progressing as regards spondylitic signs and symptoms. If these precautions are observed, we may give thorium X with a clear conscience.

Clinical trials of thorium X in Great Britain have been and are, hampered by the difficulty of obtaining it. Only one firm so far as I know supplies it for medicinal purposes and this firm is already working to capacity. The fact that the activity of thorium X falls rapidly is not in itself a bar to its use at some distance from the source of supply. A convenient solution is 100 e s u per milli-litre of normal saline solution. But it can be sent out at twice this strength so that it will fall to the standard in about 4 days. Apart from questions of expense this makes it possible to distribute thorium X by air mail over considerable distances.

I will conclude this chapter on a cheerful note by quoting the following case—not one of spondylitis but of active infective arthritis.

*Case 4*—Mr H. W. (aged 38 years). Knees swollen and painful. Generalized pains. Spindle fingers. Tonsils septic.

This patient was first seen by me on April 29, 1945. He had been advised to have his tonsils out but at the time it was very difficult to get this done owing to overcrowding of hospitals. As he failed to respond to any of the usual treatments he was sent to the thorium X clinic with a view to possible temporary relief.

The following note was made: Has very septic tonsils. Unlikely to do much good. B. S. R. 25/100. Hb. 88 per cent. White-cell count 8,000. Short trial only.

The first injection of 50 e s u produced a somewhat violent reaction. The dose was cut to 40 and then to 30 e s u. After a few injections improvement began and continued to the end of the usual course of 12 injections. The patient was then practically free from pain. The blood sedimentation rate had moved from 25 to 5, the white-cell count to 7,500 and the *haemoglobin* had increased from 88 to 94 per cent. The patient naturally wished to continue but as a bed was now available I advised him to take advantage of it. He was certainly in a much better condition to stand the operation than before he was treated by thorium X.

Note the sharp reaction following an ordinary dose of 50 e s u and the good effect of reducing the amount to 30 e s u (weekly). It may be that an average dose of 50 e s u is unnecessarily high. At any rate I advise the inexperienced to try the lower figure.

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## CHAPTER 10

### GENERAL MANAGEMENT OF PATIENTS WITH SPONDYLITIS

HITHERTO I have discussed each possible method of treatment separately, almost as if it were sufficient in itself. It is now time to integrate these various procedures, and to show their relationship to one another in the treatment of an individual patient. This involves a certain amount of recapitulation, but not, I hope, redundancy.

I shall also discuss in this chapter certain special problems connected with spondylitis, such as the treatment of the hip joints.

#### I PATIENTS IN STAGE I

Not much need be said about the treatment of patients in the pre-spondylitic stage, as the matter has been discussed in the chapter dealing with wide-field x-ray treatment. Apart from x-ray therapy, it is desirable that the patient should lead a healthy, outdoor life, in order that the resistance to the disease, engendered by the treatment, may be maintained to a degree which will finally rid him of his trouble.

The advice to lead a healthy life is too often a counsel of perfection, but it is, in my opinion, of the same importance as in early tuberculosis. Financial conditions usually make it impossible to carry out in full, but at least we can try to safeguard such patients against excessive physical or mental strain and to see that they do not work long hours in an unhealthy atmosphere.

#### *Sex incidence*

Kennedy has pointed out that whereas in a series of Scott's cases the sex incidence in pre-spondylitic cases was only 3:1 in favour of males, in the later stages it reached 7:1. He suggests that possibly not all the young females diagnosed, by virtue of limb pains and sacro iliac changes, as being cases of ankylosing spondylitis, were in fact suffering from this complaint.

But it is, of course, just as likely that the difference in sex incidence in the early and later periods was due to the same cause which determines the general preponderance in males. We know that the disease may at times be completely overcome if treated

in its early stages, and it is reasonable to anticipate that cure will be more frequent when there is a higher natural resistance. Spontaneous cure is, therefore, more likely to happen in the female than in the male.

There is also the question as to the kind of life led by the two sexes in the pre-spondylitic years. The girl between 18 and 28 years of age, if unmarried, probably has on the average less physical and mental strain than the young man of the same age.

### *Physical strain*

Many young male patients, owing to economic pressure, are forced into jobs which are really too heavy for them—for example, driving heavy lorries, or walking many miles daily as an insurance agent. Patients in such circumstances are very apt to break down after being apparently cured.

So much for compulsory physical strain. There is also the important matter of sport. Scott was strongly opposed to swimming, and barred it for all his patients. I myself forbid only the more violent sports such as football and hockey. I allow golf, tennis, cricket, swimming and cycling in moderation, having explained to the patient that in these matters each man must be his own physician and judge whether or not he benefits by such exercise.

## 2 PATIENTS IN STAGE II

The remissions produced by deep x-ray treatment to the spine are often of substantial length. Periods of 2–3 years are common, and in many instances there is complete relief for 5 years or more. An occasional repetition of the x-ray course is, generally speaking, all that such patients require.

But when the betterment lasts only a few months, and when the free interval does not increase, something else is called for. In a chronic case, I do not resort to x-rays more than once in a year, for in such cases it is evident that x-rays are not going to effect a "cure" (using the word in the sense of a complete remission lasting for years) but can be regarded only as a means of producing temporary benefit.

Suppose that a patient with severe spinal pain is relieved by x-ray therapy for only 6 months or less. This is the sort of case in which we should try alternative means of relief. These alternatives, namely, the use of vaccines—gold, bismuth and thorium X, have been discussed in previous chapters.

*Vaccines*

No definite rules can be laid down as to which of these agents should be tried first. Where the differential sedimentation test is available some guidance may be obtained. Briefly, vaccines should be the first choice if there is a small green field. But one can get along without the aid of the differential sedimentation test. Vaccines should be tried because a quicker result will follow their use than with anything else. A good trial dose is 0.02 million organisms of Charterhouse vaccine, or 0.1 million organisms of the anti-rheumatic vaccine prepared by Parke, Davis & Co. If this is the right quantity, the patient will experience relief for 3-4 days. The dose may be repeated in a week's time. If the dose is sufficient, the free period will lengthen, and after half a dozen doses should last the full week. One may then extend the interval to 10 days or a fortnight and presently it may be found that one dose in 3 weeks is sufficient. After the patient has had a course of perhaps 20 injections it may be possible to let him try "on his own." In some instances it is necessary to give a dose every month, indefinitely, if the patient is to be kept comfortable. Some patients grumble at this. I point out to them that the diabetic patient requires 2 or 3 injections of insulin each day, and that this form of treatment is considered to be a great triumph of medicine. To keep a patient with spondylitis fit for work and play by one injection a month is surely a great accomplishment, especially when it is remembered that even as recently as 10 years ago the attitude of the text books to this disease was one of therapeutic nihilism.

Of course, it is essential to find the correct dose for the individual patient. This means a dose which will produce no reaction, but which will cause almost immediate relief of symptoms. Some cases will not respond to vaccines. That is to say, if the dose is dropped below reaction point, nothing at all happens. It should be lowered again another 10 times, and if there is still no benefit, something else should be tried.

When it is possible to have long intervals between vaccine doses the treatment may be successful for an indefinite period. When a weekly dose is required, then capacity to relieve may ultimately fail, though usually not for some months.

*Gold*

When a vaccine is not effective, or has ceased to be effective, small doses of colloidal gold sulphide should be tried. A good working trial dose is 0.2 millilitre of a 0.25 per cent solution

weekly. It may be necessary to give as many as half a dozen doses before one can make up one's mind as to what the effect is, but sometimes good results are seen with only 2 or 3 doses. Once the symptoms are under control, the dose may be dropped to 0.1 millilitre and eventually to 0.5 millilitre of a 0.025 per cent solution. Next, the interval between doses should be lengthened. As with vaccine, this minute dose once a month may be found to keep away all symptoms. The effects of gold, when good, are in my experience more lasting than those produced by vaccine. Many of these monthly patients will ultimately cease to attend, and will not present themselves again for a year or two.

A patient who has progressed for 6 months on a weekly vaccine, and has then relapsed, may become pain-free again when treated with gold, but, if it is required weekly, gold, like vaccine, is likely to lose its effect. If, however, a return is made to vaccine, this may again prove effective.

### *Thorium X*

If the alternation of vaccine and gold ceases to be satisfactory, we may have recourse to thorium X. It is advisable to begin with not more than 30 e.s.u. weekly, and to watch the haemoglobin and white-cell count. If there is no clinical improvement after 8 injections, the weekly dose may be increased to 50 e.s.u. I do not think there is any advantage in administering a higher dosage than this.

A large number of patients are enthusiastic about the effects of thorium X, and are apt to put pressure on the doctor to continue it indefinitely. This is justifiable only if the dose can be reduced to 100 e.s.u. once a month. This seems to stabilize some patients, and is harmless. But if they require more frequent doses, it must be intermitted altogether from time to time, despite their protests. I never give more than 12 weekly doses without an interval of at least 2 months, even if the haemoglobin percentage and white-cell count remain satisfactory.

During this interval, one may employ vaccine or gold if there is much complaint of pain.

### *Bismuth*

Bismuth in the form of bismuth sodium tartrate should not be forgotten. It may sometimes save the situation when other remedies are failing. An injection of  $\frac{1}{3}$ – $\frac{1}{2}$  grain into the buttock (well above

the sitting down area) given once in 2 weeks may have a remarkable effect on pain, but its action is uncertain. In sensitive patients,  $\frac{1}{2}$  grain once a week may give better results.

A dozen  $\frac{1}{2}$ -grain injections are permissible in a single course.

### *Electrical treatment*

Electrical treatment, chiefly in the form of diathermy "long-wave" or "short-wave", has its place in the therapy of spondylitis, but, in my experience, not a very important place. I have myself in former years been in charge of large physiotherapy departments, and am not likely to underrate its value. As a curative agent its effects are negligible, but in certain cases it may relieve spinal pain, and thus enable a patient to carry on with his job. I am not concerned here with the use of exercises and the faradic stimulation of muscles, to which I shall refer later.

Ultra-violet ray body-baths are valuable in cases in which the general health of the patient is poor.

Finally, after the patient has been kept going for a year or more by some or all of the above methods, we may complete the circle and try x-rays once more.

### **Principle of the variation of stimuli**

I have enumerated no less than 6 different methods of treatment. It is often said that where diverse remedies are recommended, none can be of much value. But the jibe has no force when all the agents used act in the same manner, that is, as stimulants to resistance. It is a well-known surgical fact that indolent wounds become "stale" to a particular dressing, which may for a time have worked well. But when the dressing is changed, there is a further period of improvement.

We do not know of any specific remedy for spondylitis, but fortunately we are acquainted with several which work well for periods ranging from months to years. And we find, as a matter of clinical experience, that when one agent temporarily comes to the end of its usefulness another may be quite effective.

In some cases a combination of remedies may give the best results. When we study the prescriptions of the older physicians, we find they were put together in accordance with a definite concept. This was to the effect that a prescription should contain 4 elements: (1) The basis or principal active ingredient; (2) the adjuvant or that which assists its action; (3) the *corrigens*, or that which modifies and corrects its operation, and (4) the *constituens* vehicle or excipient, which imparts an agreeable form.



All this was not mere pedantry, it was based on long clinical experience. Even today, when lengthy prescriptions are out of fashion, we find it is often desirable to combine strychnine and bromide. This sounds illogical, but in practice it has been found to work well in selected cases.

In view of the above considerations I may perhaps be borne with if I say that a combination of vaccine and gold or gold and thorium X may at times work better than either separately. But this is very far from advocating "blunderbuss" therapy. I do not advocate such combinations unless it has been already proved, in a particular case, that each of the ingredients has been at least of some value when given by itself.

For example, a weekly or fortnightly dose of 0.02 million organisms of mixed vaccine may have proved effective for some months, after which period it may be found that the substitution of 0.5 millilitre of a 0.025 per cent solution of gold sulphide will give better results again for some months. When the gold in its turn shows signs of failing, a further period of improvement may at times be secured by combining the injections. Generally speaking, however, one would not resort to this combination until some other remedy had been tried, and then only if a re-trial of gold and vaccine separately had not proved wholly satisfactory.

### The hip joint

Apart from the spine itself, the hip joints in spondylitis call for more attention than does any other site. Spasm of the flexor and adductor muscles may occur quite early in stage II, and is at first nearly always unilateral. Sometimes the abductors and not the adductors are affected. When a patient takes to walking with a stick, it is usually because his balance is upset by inability to extend the femur. It is necessary to distinguish between the stoop so caused and that due to genuine kyphosis. The patient should be examined lying on his back on a flat couch. It may be found that he can lie in a perfectly normal manner provided that one leg is allowed to remain somewhat raised.

### *Diagnostic injection of procaine*

A diagnostic injection of procaine is made into the hip. A line is drawn from the symphysis pubis to the tip of the great trochanter, and the position of the femoral artery on this line is determined by palpation. At a point just outside the artery an injection of 2 millilitres of a 5 per cent solution of procaine is made. A needle,

2½–3 inches long is used, and is pushed in vertically until it is stopped by bone. The needle should be the thinnest possible compatible with reasonable strength. After waiting a few minutes, it will generally be found that the muscular spasm disappears, and the thigh can be properly extended.

The patient should now be turned on his face, and the state of the buttock muscles noted. They will usually be somewhat wasted on the affected side. The patient should now get up, and it will be found that, for the time being, he can walk without his stick. Sometimes it is necessary to inject the actual muscles as well as the hip joint.

The patient should be sent for radiological examination of the hips. In many cases there will be no radiographic changes at this stage, or varying degrees of cartilage absorption may be noted.

In the milder cases, the injection method, used therapeutically, may be all that is necessary to banish spasm and to allow normal walking. The procedure is exactly the same as that used to distinguish between functional and organic deformity. It is, however, well to combine it with exercises and faradic stimulation of the buttock muscles. The exercises consist in walking with the trunk thrown back so as to hyperextend the femur. This should be done daily by the patient, but the maximal effect will be obtained if it is done under the eye of the physician at least once a week immediately after the procaine injection. The weekly treatments should be continued for at least 2 months.

When there are radiographic signs, the injection treatment should be reinforced by local x-ray treatment. A dozen weekly treatments of 150 r at 170–200 kilovolts is a usual course.

If it proves impossible to straighten the leg, even after the injection of procaine, there will almost certainly be definite radiographic changes. In such a case it may be found possible to effect extension after a course of x-ray treatment. If not, then the case is one for the orthopaedic surgeon, with a view to arthroplasty. But it should be noted that even a successful arthroplasty still leaves the patient with his disease, and still in need of medical treatment.

### *Dangers of manipulation*

Manipulation of a hip which cannot be freely moved after injection with procaine, and in which organic changes can be demonstrated by skiagrams, is a dangerous procedure. In one

case I saw recently the left femur had been broken by an attempt at manipulation, and the limb had set in an abducted position. Presently the right hip became partly ankylosed, and, in another hospital, despite full knowledge of what had happened, the surgeon decided to attempt forcible movement. The result was exactly similar, a fractured femur which set in a position of abduction. The patient's legs are now set in a permanent V, and she cannot lie on her side to sleep. Strangely enough, however, certain advantages have occurred. Whereas formerly the thighs were fixed close together, and walking was from the knees only, she can now get about quite quickly by swinging the pelvis alternately to one side and the other. A Smith Petersen double arthroplasty has been suggested, but the patient is naturally somewhat dubious about further operative interference.

### Stiff neck

The quotation of the above case is not to be regarded as a criticism of manipulative treatment *per se*. In the hands of those who combine skill with judgment it may be most valuable but only in cases in which the general disease is, for the time at least, under control. I leave this form of treatment, with the exception of stiff neck, to those who are expert in it. Stiff neck is so common and so painful that I feel I must deal with it myself. Not, of course, in its severest form when the head is almost rigid, but when the movement is, say, limited to one half the normal range. In such cases great relief often follows a comparatively simple procedure. The muscles concerned are palpated, and the tenderest areas are marked out. They are frozen with an ethyl chloride spray and injected with 2 per cent procaine. The technique is that for myalgic spots. The needle should be moved about until a very sensitive spot is found in the depth and 0.2 millilitre of the solution is injected. Not more than 5 millilitres of the 2 per cent solution should be injected in all. It is, in fact, rarely necessary to inject so much. What is essential is that rotation, flexion and extension of the head should become painless. It will be found that the range of voluntary movement is considerably increased, and passive movement may increase the range still further.

A considerable amount of increased movement persists even after the effects of the local anaesthetic pass off and the patient should be encouraged to continue with neck exercises. In cases in which the disease is under control the relief may be permanent.

### The shoulder joint

In the rare cases when the shoulder joint is affected, injection of procaine plus local x-ray treatment may prove of value. Also, at times patients with spondylitis will be found to have myalgic spots which should be treated on ordinary lines. A long needle should be used, and pressed in various directions until the patient unmistakably winces. Half a millilitre of 2 per cent procaine should then be injected. In the search for such sensitive regions at the root of the neck, care must be taken not to puncture the pleura. If this should happen the effect is unpleasant, but not dangerous except in so far as it may shake the patient's confidence in his physician.

### Sports and games

I have a few patients whom I can keep just fit enough to do their daily work, but nothing else. They come home every night exhausted and go to bed, and they rest all the week-ends. These are sad cases, and nothing can be done for them under present economic circumstances. A long rest in a convalescent home is the least they need.

For the most part, however, patients with spondylitis are able to enjoy some form of sport. Most of them could play golf, but many have not the facilities. Tennis in these days is available for most people and patients should be encouraged to try it, especially those who have given up the game because of their disability. They will soon learn whether or not they can do it without punishment. The same applies to swimming. Cycling is one of the last things the untreated patient with spondylitis gives up, and generally is the first thing he can do when he begins to recover.

When people have been really proficient at a sport, there is often difficulty in persuading them to take part in it again. They know that they are scarcely likely to recover their old form, though they may still be "quite average." At the golf club they can no longer take on the best players, and this irks them. The physician should explain that a new attitude of mind is necessary. They must look upon the game as a health-giving recreation, and not be ashamed to play with second-grade performers, or to be conceded a stroke a hole by those whom formerly they could defeat. They must also learn to decline the invitation to a second round.

In a few instances patients with spondylitis so adapt themselves as to play nearly as well as ever.

**Breathing exercises**

There is, of course, a great tendency for the thorax to become rigid. This can to a large extent be counteracted by regular breathing exercises. These are quite simple. The patient is made to stand as erect as possible, and told to tighten his abdominal muscles. He is then instructed to draw in his breath very slowly until his chest reaches the maximum expansion possible at the moment. He holds this a few seconds, then breathes out slowly.

It is useful to place him where he can see his profile in a mirror. In all but really bad cases he will observe that he becomes visibly more upright as he fills his chest, and this gives him encouragement. He should be instructed to carry out these exercises night and morning, at the rate of not more than 4 or 5 inspirations and controlled expirations each minute. Two minutes is enough to start with, gradually increasing to 5 minutes or more. Moreover, he should become 'diaphragm conscious' and at any suitable moment throughout the day should practise thoracic breathing.

These exercises, if persisted in, will improve the patient's stance, and also make him feel more energetic. When the abdominal muscles are weak, faradic stimulation is often very helpful, and may, indeed, with profit be extended to all the trunk muscles. Great care should be taken not to over-stimulate, after such a treatment the patient should feel invigorated, not tired out.

**Minor ailments**

Patients with spondylitis suffer, of course, from all the usual ills common to man, but there are two which frequently occur: a tendency to looseness of the bowels, and nocturnal cramp. For the former, I wish to call attention to an old remedy which is not prescribed as much as it should be. I refer to bismuth salicylate. To be effective, it should be given in fairly large doses, say, 30 grains 2 or 3 times a day immediately after food. In a successful case the improvement is rapid, loose and unpleasant stools becoming formed and odourless within 48 hours. The patient should be warned not to be alarmed by their dark colour. The physical constitution of the powder is important. It should be light and flocculent. Coarse powder and compressed tablets are practically useless. If no improvement is apparent in 3 days, there is little use in persisting with this drug.

Cramp appears often to be caused by hyperacidity, and can be warded off by taking a half to one teaspoonful of bicarbonate of soda at bedtime. Here again, if there is no relief in a few days, the treatment is unlikely to be successful.

Bladder infection is an occasional complication, which does not always entirely clear up with the administration of sulphonamides. The older method of treatment by mandelic acid may work when the sulphonamide drugs have failed.

### **Pain-relieving drugs**

#### *Aspirin*

The ideal we aim at is to keep the patient free from pain by holding his disease in check by the various measures already described. Sometimes it is necessary to add analgesics. For the most part, aspirin is sufficient. No rules can be laid down as to the exact amount, it is necessary to judge each case. The neurotic patient who flies to drugs at the merest twinge of pain should be checked, but the type which has a "conscience" about drugs, and who really suffers, should be encouraged to use them in reason. Some require a certain amount daily, others only on special occasions. For instance, the patient who cannot enjoy an evening at the pictures because sitting so long in one position causes pain and stiffness may find that taking 10–15 grains of aspirin gives him a pleasant evening. He should be told to take it with an easy mind.

A few patients are not relieved by aspirin, or have an idiosyncrasy towards it. Phenacetin, or phenacetin with codeine may be tried.

#### *Cannabis indica*

*Cannabis indica* is a drug which might well be used before resorting to morphine. It has euphoristic properties which are especially valuable when there is a mental element.

Case J. H. is a patient aged 60 years, with considerable deformity, and still subject to exacerbations of spondylitic pain. For a year a small fortnightly dose of gold had controlled his pain satisfactorily. Then he was so unfortunate as to see, within a few feet of him, a man killed by a motor car. That night his pain came back in full force, and he became depressed. All the usual remedies were tried without avail. He began to lose weight rapidly, could not sleep, and I feared that he was becoming suicidal. An article by Douthwaite, recommending *cannabis indica* for the pain of gastric ulcer, led me to give this drug a trial. Douthwaite states that the official maximum dose (1 grain) of the extract is almost useless, and recommends 3–4 grains for each dose. In this case I

prescribed 2 grains half an hour before bedtime, to be followed by the same dose if he was not asleep within 2 hours

The effect was excellent. Within a fortnight he was sleeping well. The drug was gradually withdrawn, and the usual remedies were resumed. In a few weeks he acknowledged that he was back to his former condition of comparative comfort: this included peace of mind as well as of body.

The preparation given consisted of the 1 grain capsules prepared by The British Drug Houses Ltd. As the official limit is 1 grain, it is necessary to write a special letter to the pharmacist before one's directions can be written on the container. Neglect to do this leads to complications which may well frighten the patient, who not unnaturally thinks the physician has made a mistake.

### *Morphine*

Finally, there are occasional instances in which pain is so acute that morphine is required. But as patients so affected are unfit to travel to a clinic, this is a matter for the medical attendant.

I may add that I have never known a patient with spondylitis who was a drug addict.

### *Significance of pain*

Pain associated with increasing limitation of movement is of serious import, indicating uncontrolled activity of the disease. Pain unaccompanied by any clinical or other signs of physical deterioration may be psychosomatic, or even purely psychical. When continuing, or even increasing, pain is accompanied by increase of movement—when the patient says for instance, "I have more pain but I can do a lot of things I couldn't do before"—such pain is not an indication of progress of the disease, but is the natural result of bringing long-unused muscles into action. This should be explained to the patient and he should be exhorted not to worry about his pain so long as he continues to gain freedom of movement.

On the other hand, complete absence of pain is no guarantee that all disease processes have ceased. During years of freedom from pain there may nevertheless occur, almost unknown to the patient, a slow increase in deformity and rigidity. It is therefore desirable that all patients with spondylitis should be overhauled at least once a year, no matter how well they feel.

**Obstinate relapse**

Occasionally a patient will do well for many years, suffering only minor relapses, which quickly yield to treatment. Then, after a long period of freedom, a recession occurs which, though at first apparently no different from others, proves to be intractable. The whole gamut of remedies is tried without result, and the patient slowly gets worse. The blood sedimentation rate is raised, but the haemoglobin percentage and white cell count may not be markedly affected. The patient looks ill, suffers from lassitude, and loses weight.

In such cases it is worth while to try blood transfusion, but this may fail or prove of temporary benefit only. Such patients are as much in need of prolonged sanatorium treatment as is any sufferer from tuberculosis, but facilities are lacking. Whole-body ultra-violet ray baths are sometimes a help, but care must be taken not to overstimulate.

**3 PATIENTS IN STAGE III**

The majority of patients attending an out-patient clinic for spondylitis are, broadly speaking, in stage II of the disease. They are either not visibly crippled or not sufficiently crippled to prevent them carrying on with their jobs. They come because they are kept reasonably free from pain, and because they recognize that, year by year, they are, on the whole, improving.

A high degree of deformity, such as is seen in stage III, is often accompanied by the cessation of pain. But there are many who, despite extensive ankylosis, still suffer from severe pain. The first type, if they do appear, should be sent forthwith to the orthopaedic surgeon, he alone can help them. Patients in whom pain is present should be treated for it on the usual lines before being sent to the surgeon, so that if possible the disease may be rendered quiescent. Severe cases of kyphosis, with rigid thorax and oxygen starvation due to interference with diaphragmatic breathing, may, however, require surgical intervention in the form of spinal osteotomy before any progress can be made.

Short of this, the surgeon may in some cases give immediate help by devising suitable supporting apparatus.

Patients with a rigid thoracic cage are generally anaemic, with a haemoglobin percentage of 60–70. When to this is added severe kyphosis and interference with diaphragmatic breathing, the haemoglobin percentage may fall alarmingly, to 40 per cent or



less. Nor can it be restored by iron, or by liver injections, except in small degree. This is just the sort of case in which spinal osteotomy is most urgently needed, but it is, of course, dangerous to operate when the condition of the blood is so poor. Liberal pre-operative transfusion of whole blood is the only safeguard.

## CHAPTER 11

### MENTAL FACTORS: OCCUPATION, SEX AND MARRIAGE

THE "HANDLING" of patients with spondylitis is of extreme importance. It is necessary to strike the correct mean between caution and optimism. A patient treated by x-ray therapy while still at an early stage of the disease usually feels perfectly well within 3 months, and enjoys complete or nearly complete freedom of movement. He will submit to a repetition of the course of treatment because he has been told of it in advance (see Chapter 6), though he will probably consider it to be unnecessary. But when he has completed the previously agreed courses, what are we to tell him? One might gamble on the fact that some 50 per cent of such early cases are "cured", or at least have a very long remission, and tell the patient he will never have any more trouble. This is no doubt very good for his peace of mind, but what happens if he does relapse? He will return with confidence shaken in his physician, and an inclination to look with suspicion on everything he says.

Personally, I never say categorically to any patient with spondylitis that he is "cured". When the stage is early, and the chance of a long remission is good, I avoid making any prophecies unless directly asked. "Shall I ever have any trouble again?" My answer is, "It's very unlikely, but if you should have any return, come back and we'll soon get rid of it for you." My manner conveys the idea that I hardly consider the matter worth discussion. This tactic seems to work well on the whole, patients do not go in daily fear of a relapse, nor are they unduly surprised and alarmed should they have one.

When a relapse has occurred after a few months only, it is, of course, only too likely that there will be further exacerbations from time to time. One's attitude should therefore become more cautious. It is best to explain frankly to the patient the nature of his disease. We cannot, indeed, answer the almost inevitable question, "Doctor, what causes spondylitis?" but we can tell the patient what is likely to happen. For though we do not know the cause of the disease, we know its "natural history" only too well.

It is wise to tell a patient who has relapsed that he may relapse again, but at the same time to reassure him that relapses can be

dealt with as they appear, and need never become serious. There are, unfortunately, a certain small number of patients who cannot be kept reasonably fit unless they attend a clinic at intervals ranging from 2 to 4 weeks. Fortunately, the realization that they are "tied" to the clinic comes only slowly, and, by the time they realize that no definite term can be put to their attendances, they have come to look upon their fortnightly or monthly attendance as part of the ordinary routine of their lives.

# 1 PSYCHOSOMATIC PAIN

The patient who returns saying he has had a relapse is not always in need of physical treatment. Provided the symptoms are confined to pain, especially pain in the back, their causation may be entirely mental. Or mental disturbances may so lower the pain-perception threshold that impulses get through which would normally be disregarded. The possibilities are legion, embracing the whole gamut of human fears, disappointments and frustrations. In the youngest class of patient, that is, the patient in the late teens, the trouble is usually some clash between the boy's will and that of his parents. One young man, who was an undergraduate at Cambridge, complained bitterly of pain, though his blood sedimentation rate reading was but little affected. I ultimately found out that he wanted to go into business, and that his father was more or less forcibly making him stay at the University. I talked to the father, and the boy was allowed to go his own way. That was 3 years ago, and, so far as I know, there has been no pain since. This boy had definite sacro-ilitis, and was a patient in the first stage of spondylitis. There was no element of conscious malingering in the complaints he made of pain, although the physical side of his malady had been satisfactorily dealt with by x-ray therapy.

Another youth of about 22 years of age, also in stage I and similarly treated, came back repeatedly for a period of 18 months complaining of pain. I could find nothing in his circumstances to suggest a psychical origin, yet there seemed to be no physical reason for his pain. However, at the end of this period, he suddenly announced that he was going to marry and did so, a child was born within 12 months. I have had no complaints from the patient for 2 years.

Love affairs are not, of course, the only cause of trouble. An unsuitable job, differences with superiors, fear of an important examination and domestic quarrels also come into the picture.

We must not label these pains as imaginary. The malingerer imagines pains, but only for the benefit of his doctor. If a straightforward person complains of pain, he feels it. Pain is always real, it may or may not have a detectable physical basis. Knowing spondylitis as we do, it is impossible to assert in any given case that there is no physical basis for any pain complained of. What happens in many cases is a "lowering of the threshold", that is to say, that stimuli which would not normally reach the conscious level do so when the subject is depressed. A thorough physical examination, followed by reassurance, has a beneficial effect in some cases, and a sympathetic talk with the patient about his difficulties may help in others. But there remain a number in which nothing but a removal of the cause will give relief.

## 2 SEX, MARRIAGE AND INHERITANCE

In the well-established case of spondylitis, the sex appetite is almost always diminished. Inquiries among married patients show that intercourse takes place less frequently than among normal people. This may be due in part to the fact that intercourse is not infrequently followed by some unpleasant consequences such as return of pain in the back, where normally there is none, or a feeling of general exhaustion the next day. But in most cases it seems to be due to a lessening of libido. There is not, however, any failure of potency, and I know many cases in which patients in the second stage of spondylitis have three or four healthy children.

Patients contemplating marriage often ask my advice concerning the possibility of passing on their malady to their prospective children. Years ago I was very confident in telling them they need have no fears, now, I am less certain. Several instances have occurred in my practice of twins both suffering from spondylitis at the same time, of brothers developing the disease at different periods of their lives, and two cases only where a brother and sister were affected. Also, several cases of father and son, and uncle and nephew, have been experienced. We know that tuberculosis is not in the strict sense hereditary, but suitable "soil" is. Hence, the expression, "they are a tuberculous family". If spondylitis is due to a glandular defect, we should expect it to be *usually* inherited, if it is due to lack of resistance to some germ or virus that same lack may be transmitted by parents to their offspring. Statistics are lacking, but it is safe to say that inheritance is not common. What I now tell such inquirers is that while there is no

likelihood there is a possibility I then say that in my opinion this possibility is not a ground for avoidance of marriage I point out that one who has spondylitis himself is unlikely to miss the first signs of it in any child and that proper treatment at an early stage will usually abort the disease or at worst will prevent the development of deformity

I also point out that intercourse should be graded in frequency according to whether or not it produces unpleasant after effects Whenever possible I see the prospective bride and explain the situation to her as well as to the patient I have never yet known an engagement broken off as a result of this plain speaking

Perhaps the greatest difficulty is in cases in which the disease develops a year or two after marriage Some women are apt to resent a slackening of marital ardour and put it down to any cause except the true one The only cure for this is to see the wife and carefully to explain matters This is not always successful I have known wives seek satisfaction elsewhere in such circumstances In one case I know a young man married to a worthless wife stole from his employers in order to get money to placate her with a good time He spent six months in jail and when he was released she had deserted him in which I told him he was very fortunate

On the other hand the patient in the early stage of spondylitis may be sexually hyperactive This results either in excessive masturbation or in the case of a highly controlled individual in frequent nocturnal emissions These do far more damage than does masturbation In both cases the administration of oestrin is very valuable It should be pushed to a point at which there is slight soreness of the breasts One half grain tablet of stilboestrol at night is sufficient and may in some cases be too much It is most effective in the treatment of nocturnal emissions but is also a useful aid in reducing the desire for masturbation

As time goes on desire drops again to normal or subnormal according to the general progress of the case The excessive loss of semen must however be checked or the usual remedies will not succeed

### Pregnancy

The effect of pregnancy upon spondylitis is difficult to gauge There is no proof that the disease is made worse on the other hand I have never observed a dramatic improvement such as may occur in rheumatoid arthritis Young women with spondylitis in active form do not usually marry if they do they take

precautions to avoid conception. This means, in practice, that pregnancies begin at a time when the patient is in a stage of remission, and there are for the time being no symptoms to be relieved.

I recall only one case in which I was called on to relieve spondylitic pain during pregnancy. Obviously x-rays are out of the question in such circumstances, the safest remedy is a vaccine, and, in the particular case to which I refer, vaccine treatment proved effective. Had it failed, I should have resorted to small doses of gold sulphide. Thorium X, in my opinion, could be used with perfect safety, but I should not advise it, because, if for any reason there was a miscarriage and radiation in any form had been administered, the treatment would be blamed for it.

This particular patient had had previous exacerbations, and there is no reason to assume that there was any causal connexion between the pregnancy and the attack.

Then there is the important question of delivery. If the sacro-iliac joints are sclerosed, wholly or in part, the amount of "give" in the pelvis is obviously reduced. An extreme case would be complete ankylosis of the sacro-iliac joints and ankylosis of the pubic symphysis (I have not seen the latter occur but it is said that it may happen) (Parr and Shipton, 1946). Under such circumstances the pelvis would be absolutely rigid. Even in such a case Caesarean section need be contemplated only if careful radiographic pelvimetry shows the foetal head to be abnormally large in relation to the pelvic canal.

In every case, therefore, when a woman known to have spondylitis becomes pregnant, two things must be kept in mind.

(1) Unless the sacro-iliac joints have been radiographed very recently they should be re-examined. If they are still in the stage of decalcification, special steps are not called for, as the elasticity of the pelvis will be rather increased than lessened.

(2) If, however, any degree of sclerosis is shown, pelvimetry is essential, and to neglect it is criminal.

Before I leave this subject, I wish to repeat the warning that any patient whose menses have been made irregular or which have been temporarily suppressed by x-ray treatment, should not allow herself to become pregnant until the menstrual rhythm is completely restored.

### 3 FAMILIAL INCIDENCE OF SPONDYLITIS

Since writing this chapter, my attention has been called to the researches of H. F. West, M.D., M.R.C.P., of Bristol, on the

subject of the familial incidence of spondylitis. These researches are embodied in a thesis for the M.D. London (1948), which may be consulted in the University Library. For the purposes of this book, Dr. West has very kindly furnished me with a summary, which is now quoted.

The part played by heredity in the aetiology of the disease has been under discussion since the first cases were described at the end of the nineteenth century. Many articles have been written to describe short series of cases, especially on the Continent, and in almost every instance reference has been made to the occasional occurrence of two cases in one family.

Gelinger (1918), in an extensive review of the German literature, paid particular attention to the factor of inheritance. He quoted a series of 58 cases of the Bechterew type, in 8 per cent of which inheritance was considered to be the main aetiological factor, a series of 86 cases of the Strumpell-Marie type with 2 per cent attributed to heredity, and a further series of 40 mixed cases with 12 per cent ascribed to heredity. We do not know how many of these cases would have conformed to our present criteria for the diagnosis of ankylosing spondylitis, nor do we know in how many cases hearsay evidence was accepted, what is clear is that the aetiological significance of heredity was much in the minds of physicians in the first decade of the century.

In 1936 Claussen and Kober reviewed the literature concerning the familial incidence of the disease since Gelinger. Few reports of related cases had appeared in the intervening years. They pointed out the fact, so often forgotten, that history-taking does not reveal nearly so much as a thorough investigation of the family. They investigated the families of 10 patients out of 81, the others, they said, were too difficult to contact. In these 10 families they found 9 secondary cases, 4 patients being alive and 5 dead (3 with medical evidence and 2 without). They found 1 secondary case in each of 3 families, 2 in 1 family and 4 in 1 family. Although they did not support their statements with much detail their evidence is certainly impressive.

In 1948 an abstract was published of a paper read to the American Rheumatism Association by Rogoff and Freyberg. These workers found 34 families with histories of back disability among the families of 114 patients with 'rheumatoid spondylitis'. They examined 18 of these families and found 10 with multiple cases. They estimated the family incidence as from 9-13 per cent.

In the discussion that followed the reading of this paper, Dr. Polley said that he had found a family incidence of only 0.4 per cent among 1,035 cases at the Mayo Clinic and Dr. Talkov reported having found an incidence of 5.9 per cent among 230 cases.

Before stating evidence for the familial incidence of the disease, it is necessary to define exactly what one has considered essential for the diagnosis. It is also necessary to estimate the incidence of the disease in the general population before drawing conclusions.

as to the significance of multiple cases within sibships West (1948) in a study of 100 run of the mill cases at a general hospital concluded that radiographic evidence of bilateral sacro ilitis was diagnostic of ankylosing spondylitis for the following three reasons

(1) Most cases showing radiological evidence of bilateral sacro ilitis do subsequently develop radiological evidence of involvement of the spine (of 45 patients seen who at first showed evidence of sacro iliac foci only no less than 32 had already progressed to involvement of the lumbar spine)

(2) It is not possible to differentiate radiologically between these sacro iliac foci which have been followed by spinal involvement and those which (so far) have not

(3) Cases showing radiological evidence of sacro ilitis only are found among the siblings of some severely affected patients (*? formes frustes*). In order to decide the minimum requirements for a definite diagnosis of bilateral sacro ilitis West studied the radiographs of 40 normal university students. Such criteria as lack of definition of the joints a ground glass appearance and haziness were found to be unreliable guides and for the purpose of the study multiple circumscribed areas of sclerosis or relative osteoporosis in the lower part of each joint was taken as the minimum requirement for a definite diagnosis. Cases with typical early symptoms and signs but without this radiological confirmation were not accepted.

As the only estimate made of the incidence of the disease in the general population had been made on post mortem findings (Schmorl and Junghanns 1932) West attempted to estimate the incidence of the disease in the city concerned (Bristol). There was good reason to believe that almost all the cases diagnosed within the city in the previous 5 years had been referred to one hospital. It was thus possible to construct a histogram depicting the number of cases in 5 year age groups and assuming an average age at death of 60 years to make a rough estimate of the number of cases missed through having become burnt out or quiescent before the investigation began. It was found that the incidence in the population of 420 000 was at least 1 in 2 000. A further assumption made was that World War II had not occasioned an increase in frequency. This question was discussed in Germany after World War I as it has been in England of recent years. The general opinion has been that the two wars caused a concentration of cases rather than an increase in total number.

Of the 100 patients studied 10 knew so little of their families that the recording of their family history was worthless. The remaining 90 patients came from 83 families. Among these 83 families a further 4 secondary cases were found. Ignoring 1 affected father since the investigation of parents was far from complete there were 9 instances of multiple cases within 83 sibships an incidence of approximately 11 per cent. If one assumes the rough estimate of the incidence in the general population to be correct then this finding is more than 100 times greater than would be expected in a random distribution.



## MENTAL FACTORS OCCUPATION, SEX AND MARRIAGE

It has been objected that a similar familial incidence might be found for tuberculosis. This may be true, but there is plenty of evidence of the infection of unrelated contacts in the case of tuberculosis and none in the case of ankylosing spondylitis. Further, affected siblings do not tend to be affected at the same time but rather at a similar age period, and 10-15 years may separate the onset of the disease in one and another.

These findings, pointing so strongly to the existence of an inherited factor, led to speculation as to why 9 out of every 10 women who had presumably inherited the abnormal genetic material failed to manifest the disease (West, 1949). The possibility that the inherited material had to be more penetrant to affect a female prompted a further study of the families of those women who had manifested the disease. It was found that, of the 10 women who had brothers, no less than 4 had an affected brother! Regarding this latter rather startling discovery it must be pointed out that the numbers are small and that confirmation from other detailed studies are awaited.

Work is in progress with a view to determining the mode of inheritance (Stecher, 1949). Gates (1946), from a review of the literature up to 1946 gave his opinion that the disease was not inherited "as a regular dominant nor (probably) a simple recessive" but that "some other factor, environmental or genetic, is required for its appearance."

What is the practical upshot of the above as regards marriage? I wrote to Dr West for his opinion, and his reply is "I would not go further than to advise against cousin marriage within the affected family." I concur in this, and also suggest that it would not be very wise for a patient with spondylitis to marry into a family with a history of the disease.

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## CHAPTER 12

### CORTISONE AND PREGNENOLONE IN THE TREATMENT OF "RHEUMATISM", INCLUDING SPONDYLITIS

AT THE Seventh International Congress on Rheumatic Diseases interest was dominated to a large extent by the Mayo Clinic researches into hormone effects in rheumatoid arthritis. I am permitted by Dr Philip S. Hench to reproduce the following summary of his paper which dealt with the adrenal hormone compound E, first isolated by Edward C. Kendall, who named it cortisone (Leading Article, 1949)

The adrenal cortical hormone 17-hydroxy-11-dehydrocorticosterone (compound E) has been administered to 16 patients with severe or moderately severe rheumatoid arthritis. In each case improvement in clinical features and in sedimentation rates began to occur within a few days. When administration of the hormone was discontinued the disease generally relapsed promptly. Compound E has been given, with encouraging results, to 3 patients with acute rheumatic fever and to one patient with lupus erythematosus with polyarthritis.

Essentially similar clinical results accompanied by various biochemical effects, including reduction of sedimentation rates, were obtained from the administration of the pituitary adreno-corticotrophic hormone (ACTH) to 4 patients with rheumatoid arthritis.

The rarity of these compounds presently and in the immediate future and the limited scope of our preliminary data (especially regarding prolonged administration) make inappropriate now the use of the term treatment except in an investigative sense. This paper is presented, not as a clinico-therapeutic report, but as a study of certain physiologic effects which these new hormones exert on rheumatoid arthritis.

To provide adequate controls, the injections of the adrenal cortical hormone were in some cases preceded in other cases replaced, by injections of a preparation of similar appearance, a suspension of cholesterol. The times when the control solution and the adrenal hormone were interchanged were unknown to the patients, and were for 5 weeks unknown even to the 3 clinical authors who were evaluating the results. When injections of the control solution were first administered for a few days, no outstanding clinical or biochemical alterations occurred until these injections were replaced by injections of the hormone. Likewise, when the adrenal hormone was replaced by the control preparation, articular and muscular symptoms recurred within a few days and sedimentation rates rose.

## CORTISONE AND PREGNENOLONE IN TREATMENT OF "RHEUMATISM"

The changes in the function of joints and muscles were demonstrated by motion pictures taken before, during and after the administration of the adrenal cortical or the pituitary adreno-corticotrophic hormone

Spondylitis is not mentioned in the above report, but Dr Hench told me in the course of a personal conversation at the Mayo Clinic that he had had good results in 2 cases of this complaint. Dr Hench estimates that material for a general trial will not be available for 2-3 years.

The treatment of rheumatoid arthritis today is, of course, a much more serious problem than is that of spondylitis. X ray treatment in the latter is reasonably effective in maintaining the capacity of patients for work and play.

Frank P. Foster and James D. Gillespie of the Lahey Clinic, Boston, in a paper read at the Congress, have reported on 100 patients given roentgen ray therapy, and observed by them over an average period of 15½ years. As a practical measure of the therapeutic effectiveness offered by x ray treatment, the current ability to work in the entire group was tabulated. Eighty-eight per cent were found to be at full-time work, 9 per cent at part-time work, and only 3 per cent were totally unable to work. The work involved is about evenly divided between office work, light manual labour, and heavy manual labour.

These figures correspond with those in my own experience. If they are compared with the working capacity of a similar number of rheumatoid arthritis patients, the relative efficiency of the treatment employed will be apparent at once. But there is no ground for complacency, we still need a remedy more nearly approaching a specific than any we now possess.

It must be remembered that, so far as experiments have yet gone, even if we had quantities of the famous compound E we should possess no more than a means of banishing symptoms so long as the drug was exhibited. Why this should be so is not known, but Dr Hench and his colleagues are emphatic that the action is not a form of substitution therapy.

The Mayo Clinic workers are primarily interested in rheumatoid arthritis, Professor Roland Davison and his co-workers at the Stanford University School of Medicine are attacking the problem of spondylitis *per se* along similar biochemical lines.

With Professor Davison's permission I quote extracts from his paper read at the Seventh International Congress.

Increased urinary excretion of 17-ketosteroids has been demonstrated in ankylosing spondylarthritis (Marie-Strumpell disease)

It is observed in both male and female patients and is present in early cases with little demonstrable joint change as well as in those patients who have had the disease for many years and show the typical findings of the advanced case

△ Pregnenolone is a steroid having several actions not characteristic of other steroids. Its chemical composition makes it a logical process material to act as a precursor of many active steroids. When normal individuals are subjected to acute stress and fatigue adrenal cortical activity is accelerated and increased rates of 17 ketosteroid excretion are observed. Pregnenolone administered under such conditions lowers the 17 ketosteroid excretion, improves performance and combats fatigue. This steroid has not to our knowledge been used in disease states. Its general properties, freedom from toxicity, its ability to lower urinary 17 ketosteroid excretion and to combat fatigue suggested to one of us possible value in spondylarthritis. △ Pregnenolone acetate in vegetable oil was administered by intramuscular injection daily to patients with active spondylarthritis. Urinary 17 ketosteroid excretion was studied before and during the course of administration of the pregnenolone.

Pregnenolone reduced the excretion of 17 ketosteroids in the urine of these patients to normal levels. Accompanying the reduction of 17 ketosteroids is a definite beneficial effect on symptoms and objective signs of the disease.

I am bound to point out that many authorities in the United States of America dispute the accuracy of this work so far as excretion of the 17 ketosteroids is concerned, but we must be careful to separate clinical results from laboratory findings. Professor Davison told me in conversation that in one case to which △ pregnenolone was administered chest expansion increased in 2 months from  $\frac{1}{2}$  inch to  $3\frac{1}{2}$  inches. This is an achievement of a most remarkable nature and one sincerely hopes that such successes may be repeated. I am told that Armour and Company Limited are considering the possibility of manufacturing the substance concerned.

It seems clear that the adrenals are involved in the production of the spondylitic syndrome. Scott was of the opinion that he got his wide field results in part by affecting the adrenals and although wide field is now little used it is of course impossible to drench the spine with deep x ray without bringing the adrenals into the field.

It is to be noted that at the Mayo Clinic similar results to those obtained by using compound E were produced by the administration of pituitary adrenocorticotrophic hormone (ACTH). Possibly future research may discover a therapy electrical or chemical which will directly control these ductless glands and their products.

Let us not suppose that a miraculous cure of spondylitis is just around the corner. The whole history of medicine warns us to expect snags when new remedies are introduced. The unexpected development of bacterial strains resistant to penicillin is an instance in point. As regards compound E, already there have been some unpleasant side-effects such as virilism in women patients.

What, then, does all the foregoing add up to? To this there can be no radical changes for at least 2 years, and not necessarily then. Meanwhile, this book will remain what it claims to be: "A practical guide to the diagnosis and treatment of ankylosing spondylitis".

One word more: in the course of a conversation with Dr. Smith Petersen in Boston, he stated that he remained fully satisfied with the results of vitallium mould arthroplasty in spondylitis, and permitted me to quote him to this effect:

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## CHAPTER 13

### CONCLUDING REMARKS

#### 1 THE PATIENT AND HIS DOCTOR

TO ANYONE who has read thus far it will be evident that the treatment of established spondylitis requires team-work of a high order. Nevertheless, it is very important that some individual member in this team should be generally responsible for the welfare of the patient. Many patients I see have already received much treatment of a sporadic nature at various hands, but complain that they "belonged to no one".

As radiological treatment is the most important in the early stages, it would be logical to make the radiologist responsible for the care of these cases. Unfortunately this is not usually practicable. Most radiotherapists are chiefly concerned with cancer, and are apt to regard anything else as a "side-line". It is true that the Faculty of Radiologists insists on a high standard of general medicine for its Fellows, and that this part of its examination is conducted in co-operation with the Royal College of Physicians. It is, therefore, often the will rather than the knowledge which is lacking. In fact, there are not many radiologists who have either the time or the inclination to take general charge of patients with spondylitis.

The next choice is the physician. If he has had a training in radiotherapy, and can prescribe x ray treatment, there is, of course, no difficulty. But this combination seldom occurs, and he must send his cases to the radiotherapist, looking to him to deal with technical details. Nevertheless it is essential that the physician should be able to recognize the signs of overdosage, and his should be the final word and, of course the ultimate responsibility.

#### Role of the general practitioner

Where does the general practitioner come in? It is to him in the first place that the potential patient with spondylitis will come. His duty is to recognize the earliest signs. In many cases, unfortunately, he will not recognize them, but let us hope that at least he will take action before permanent damage is done. He will then send the patient to a rheumatism clinic, or to a medical out-patient

## CONCLUDING REMARKS

department if no special clinic is available. Here let us suppose the patient is examined radiographically and a diagnosis is made.

The physician sends him for x-ray treatment, and his symptoms disappear. In a great many instances, the general practitioner will not see the patient again. He is either "cured", or kept comfortable by occasional courses of x-ray treatment. But suppose he is the type of patient who can be kept fit for work and play only by alternating the various methods I have described? So far as vaccines, gold and bismuth are concerned, there is no reason why the general practitioner should not treat the patient, if he will take the trouble to familiarize himself with these methods in relation to spondylitis. Thorium X is not, as a rule, suitable for exhibition except under detailed direction.

What is really important is that the practitioner should realize that spondylitis is not today a hopeless disease, but that some cases require constant attention. This is best supplied by attendance at a special clinic, but, when circumstances do not permit such attendance, the family doctor (if the term is still permissible) can himself do a great deal to help such patients.

## 2 PSYCHOLOGICAL EFFECT OF ATTENDANCE AT CLINICS

It is possible, in large centres, to group patients with spondylitis into special clinics. This method has much to be said for it. If there is a physician in charge who has a special interest in the victims of this disease, a feeling of confidence, of being properly looked after, is bred among those attending. It is also very convenient for the collection of statistics, for the efficient working of a follow-up system, and for assessing the value of a particular form of treatment.

An objection is that the early and more-or less curable cases are confronted, in the waiting room, with the severely crippled, and that this may give rise to alarm and despondency. Personally, I have not found that this is a serious drawback. More often than not, if there is confidence in the physician, it gives rise to a feeling of thankfulness. "When I see some of the people here, I feel that I should not complain. I am lucky to be no worse, and to have the prospect of becoming better." In a few hypersensitive subjects, alarm is certainly produced.

But there is another side to this question. Since the introduction of arthroplasty and spine-straightening procedures it has become evident to all that even apparently hopeless cases can be enormously improved. The reappearance in the waiting-room of a

known cripple, now able to look straight ahead, and walking with mobilized hips, is hailed as a surgical miracle, which indeed, it is

There are, of course, other possibilities of grouping in a large rheumatism clinic. For example, the elderly sufferers from osteoarthritis may be separated from the young sufferers. This would mean the grouping together of young patients with spondylitis with young victims of, say, rheumatoid arthritis, and would amount to a separation of the probably curable from the incurable. I have no experience of such grouping, and mention it merely as something which might be tried.

### Need for rest

The experience of many years has convinced me that the great majority of patients with spondylitis can be successfully treated in an out-patient clinic. This is fortunate because on the one hand, few can afford to be absent from their work for long periods, and, on the other, the hospitals are overcrowded and beds are difficult to secure. In the case of those who show increasing deformity despite treatment, rest is, of course, essential, and it must be medically supervised in order to secure that there is no avoidable ankylosis of joints. A few special "rest centres", analogous to sanatoria for patients with consumption, are badly needed.

### 3 PROGNOSIS

The change in the outlook on spondylitis which has come about during the past decade can best be illustrated by a quotation from the *British Encyclopaedia of Medical Practice* (Buckley, 1936). It does, indeed, show some advance on the article on spondylitis in Allbutt's *System of Medicine* in 1910 in which reference either to prognosis or to treatment is discreetly missing. The reader of the article in the *British Encyclopaedia of Medical Practice* will find both prognosis and treatment discussed.

Under "Course and Prognosis" this is what he reads

Spondylitis is not likely to prove fatal by itself but death may result from intercurrent conditions

Intermissions commonly occur and there may be a quiescent period of many months or years. Then pains such as heralded the original onset appear and the ankylosing process again becomes active. In this way the whole spine becomes rigid, the thorax fixed, the hips ankylosed and often almost complete fixation of the mandibular joints completes such an appalling picture that death is welcomed.



## CONCLUDING REMARKS

After this gloomy summing-up come a few paragraphs on treatment. Vaccines and x-rays are mentioned, but nothing is said as to how far, if at all, treatment can modify prognosis.

This 1936 edition of the *British Encyclopaedia of Medical Practice* is still the latest available at the time of writing. There are, however, supplements up to 1949, one of which contains a reference to the symposium on spondylitis at the meeting of the Faculty of Radiologists, to which I contributed the paper on prognosis (Hernaman-Johnson, 1945).

Prognosis is of vast importance in this malady because it attacks the young at the outset of their careers. What is likely to happen? The doctor in charge wants to know, the parents want to know, the patient wants to know. The doctor, owing to ignorance of what can be done, is often pessimistic, and is likely to have transmitted his pessimism to the parents, if not to the patient. After successful x-ray treatment, doctor and relatives rush to the opposite extreme. Is it wise to cast any shadow on this new-found optimism? The doctor should be told all the possibilities, good and bad, the parents should have a carefully edited version of what is said to the doctor. If the patient is still under parental care, it is not necessary to discuss the matter with him, but if he asks point-blank, "Shall I ever have any more of this trouble?" he should be told something of the truth. Frankness is nearly always desirable. The patient who thinks that he is quite cured, and later on has a recurrence, may develop a grievance against his doctor and against the world in general.

The prognosis is good as regards continuous capacity to earn a living. Nearly all the patients with spondylitis on my lists are holding down ordinary jobs, and during World War II often did more work every day than the average man would do in times of peace. "White-collar" work is usually the most suitable, but I have among my patients lorry-drivers, shipwrights, railwaymen, agricultural labourers and one customs official, whose duty it is, with the aid of a rope ladder, to board ships at sea!

There are few diseases in which the prognosis is so vitally affected by treatment. The outlook in diabetes mellitus was entirely altered by the introduction of insulin, but this drug must be injected daily, and crises arise which call for skilled treatment. The medical expert on diabetes mellitus is chiefly concerned with the proper use of one particular drug, the specialist in spondylitis must familiarize himself with many therapeutic weapons. But if he learns to handle these weapons with skill, he can keep his patients with spondylitis on the active list for an indefinite period.

### General prognosis

Successfully to prophesy exactly what will happen in an individual case would call for the services of a crystal-gazer rather than for those of a physician. It is, however, possible to say what will happen in the case of that mathematical myth, the "average" patient! Assuming a "live" list of 500 patients on the books of a clinic, 25 will be seen every week by the physician, and there will be 30 attendances at the radiotherapeutic department. This means, on average, that each patient is seen 2-3 times a year by the physician, and has 3 x-ray treatments per annum. In practice, half of the 25 patients seen each week are "chronics", attending regularly from once a week to once a month. Also, patients in the first year of their attendance account for a large proportion of the x-ray treatments. All this means that the majority of patients put little strain on the clinic after the initial 12 months. In giving these figures, I assume, of course, that the clinic is run on the principles enunciated in this book. At any moment some chemical or biological discovery may render these principles obsolete by providing a specific remedy, meanwhile we have to deal with patients not tomorrow, but today.

### Malignant spondylitis

In some instances, fortunately very few, spondylitis may run a malignant course, unchecked by any of the usual remedies. I have seen 3 or 4 such cases, and made the mistake, as I now see, of trying to deal with them as out-patients. They require rest in hospital, with carefully carried out passive movements. Sometimes ankylosis will proceed rapidly despite the most skilled treatment. The back does not matter so much, because it is possible to secure that it becomes a genuine "poker back". With the hips it is a different matter, and, until recently, the patient's fate was to be severely and permanently crippled.

Some years ago I had a case of this type in a young man aged 20 years. No treatment appeared to be of any benefit, and I witnessed him becoming more and more lame week by week. Finally, I began to think of a blood transfusion, but, by this time, the patient was not unnaturally "fed up" and ceased attendance.

Two years ago, Mr. Law arranged to show me some of his arthroplasty cases, operated on by the Smith-Petersen method. I remember we first had tea, and I expounded the view that cases properly treated in their early stages should never require surgical intervention. We then went to the wards, and the first patient I

## CONCLUDING REMARKS

saw was my old acquaintance whom I had had the opportunity of treating at "an early stage" He had been operated on, and now had good mobility in both hips

This was a severe reminder that vainglorious boasting is apt to get one into trouble Nevertheless, I was rejoiced to see that a medical failure no longer of necessity meant lameness for life

I have not had the opportunity of personally treating such malignant cases in hospital, but I have had brought to the clinic on stretchers patients who were able to walk a few weeks later I therefore venture to suggest to those in charge of beds occupied by patients with severe spondylitis that blood transfusion followed by the extremely careful use of the various remedies I have dealt with might improve results There is perhaps some danger that the physician, impressed by the miracles of modern surgery will begin to think that it does not greatly matter if the hips ankylose but it must be remembered that no major surgical procedure is without its mortality, and that every recognized medical measure should therefore be tried in order, if possible to avoid the necessity for taking an operation risk

One thing is certain Such patients are quite as much in need of hospital care as are the tuberculous patients who fill our sanatoria

In the case of some patients who really ought to be lying on their backs by reason of slowly increasing kyphosis, but who are otherwise in good health it is sometimes sufficient to prescribe a light plaster jacket provided with a collar or other means of preventing the head from sagging forward But here I begin to encroach on the field of orthopaedic surgery which is the province of my colleague, Mr Law

## 4 CONCLUSION

In concluding my section of this book I wish to emphasize three things

- (1) The key to early diagnosis lies in the sacro-iliac joints
- (2) There is no such thing as routine treatment for spondylitis, every patient presents an individual problem
- (3) All our remedies are non specific and overdosage with any of them may have serious results

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# ANKYLOSING SPONDYLITIS

## PART II

### INTRODUCTION

THE ROLE of the orthopaedic surgeon in the management of ankylosing spondylitis has increased in importance considerably with the realization that both conservative and operative measures are of value in all phases of the disease. Until recently there has been a tendency to allow the disease to burn itself out before considering any reconstructive measures, but the value of surgical methods in the prevention and overcoming of deformity in the earlier and more acute stages of the illness has been recognized for some time.

Surgical treatment, therefore, may be considered under three main headings

- (1) Conservative treatment
- (2) Correction of deformity
- (3) Joint reconstruction or surgery to restore function

## CHAPTER 1

### CONSERVATIVE TREATMENT

#### 1 PROTECTIVE SPLINTAGE

THE OBJECT of protective splintage is to maintain the joints in the position of optimal function, and at the same time to relieve pain and muscle spasm. Such measures are supplementary to all forms of medical treatment which aim at arresting the disease. It must be realized that, as a rule, the course of the disease consists in a series of remissions and relapses, so that it may be necessary during treatment to use protective splintage on more than one occasion. It is obvious, therefore, that throughout the whole illness there must be close co-operation between physician, physical medicine expert, orthopaedic surgeon, and radiotherapist. They must work as a team.

Splints must be carefully moulded, strong yet light: they are usually made of plaster of Paris, though lately plastic materials have been tried. Plaster is best applied over a single layer of stockinet, the sites of undue bony prominences being protected by felt padding. In the commonest form of the disease (which involves the sacro iliac joints, spine and hip joints), a plaster bed or posterior shell is ideal for the patient's comfort and nursing and to aid the latter an anterior shell is also helpful. The plaster bed is mounted upon a wooden stand, and this enables the patient to be transported relatively easily. As regards the spine, it is important to maintain the normal curves as far as possible and to avoid both excessive flexion and lordosis of the lumbar regions. Too frequently the use of the plaster bed is delayed until there is a rigid dorsal kyphosis, a result of the patient being nursed on a bed with a soft mattress, propped up by pillows and without a fracture board.

The hip joints are immobilized in slight flexion (maximum 20 degrees), slight abduction and in neutral as regards rotation. Adductor spasm with flexion, adduction, and internal rotation deformity is best counteracted by some form of extension. A straightforward Buck's extension or Hamilton Russell traction is an effective method of carrying this out (Fig. 21) due regard being paid to putting joints which are not involved through a daily range of movements. Skeletal traction using a tibial transfixion pin, or

skin traction on a Thomas or Hodgen splint with a Pearson knee attachment allows free movement of toe foot ankle and knee joints

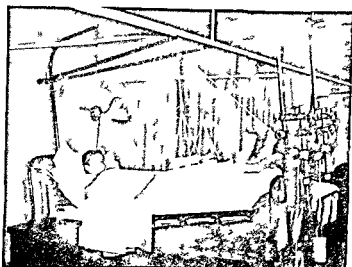


FIG 21 Correction of deformity. Traction employed to overcome hip and knee flexion deformity

During the whole period of immobilization it is essential to maintain muscle power and tone to the greatest possible extent and this is achieved by a full physiotherapeutic regime with active exercises and muscle contractions faradism massage and heat in both superficial and deep forms

## 2 PHYSIOTHERAPY AT THE AMBULATORY STAGE

When an ambulatory stage is reached symptoms having subsided and the sedimentation rate having returned to normal splints such as the long spinal support and block leather hip spica should be used to prevent pain and deformity

The physiotherapy regime must then be intensified and should include the following

- (a) Heat—diathermy infra red ray or hot wet compresses
- (b) Active exercises to develop the erector spinae and shoulder girdle muscles and to relax the hip flexor abdominal thoracic and anterior shoulder girdle groups
- (c) Deep breathing exercises to increase chest expansion

## CONSERVATIVE TREATMENT

(d) Hydrotherapy and swimming exercises together with postural training

Only by carefully supervising such a regime can deformities be held in check or corrected, with relief of muscle spasm and restoration of tone and power in the weaker muscle groups. The patient should sleep on a firm mattress with fracture boards, and should avoid fatigue and over-exposure.

Occupational therapy together with vocational training may also be of extreme value in building up the patient's morale and, subsequently, in enabling him to earn a living.

## 3 RECONSTRUCTIVE SURGERY

My interest in reconstructive or functional surgery in ankylosing spondylitis was stimulated by the work of Smith Petersen, Larson and Aufranc at the Massachusetts General Hospital, Boston, which I visited during 1946, while holding a Rockefeller Medical Traveling Fellowship. An outstanding feature was the close co-operation between the physicians on the arthritic service of the Massachusetts General Hospital, of which Walter Bauer is the head, and the orthopaedic service, and it must be realized that though surgery may often play a dramatically important part in correcting permanent deformity and restoring a certain degree of movement in the ankylosed joints, the medical or constitutional treatment of the disease must be continued, if necessary, during the post-operative regime just as much as in the earlier stages or acute phases of the disease.

The restoration of joint function enables muscle tone and power to be re-developed and improves the patient's general well-being, but the course of ankylosing spondylitis characteristically consists of a series of exacerbations alternating with periods of remission. The former still require medical control and even conservative surgical measures after operations have been performed.

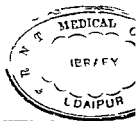
Operations are best carried out during a quiescent period when the pain and muscle spasm are minimal and the sedimentation rate has fallen to within normal limits. Ideally, the disease should have completely run its course, but in a large number of cases there is a danger of waiting too long for this to occur, atrophy and fibrosis of muscles and ligaments may follow to such an extent that restoration of elasticity, tone, and power of contraction is extremely difficult. Physical medicine and x-ray therapy may help in hastening the so-called "burning out" of the disease, and such measures may be employed to combat any tendency to "flare" during or after the operative regime.

**Indications for operation**

Restoration of joint function before there is complete muscular atrophy and ligamentous or fascial fibrosis, is of great value to many of these patients (who normally belong to a young age-group), even though subsequent reactivation of the disease may necessitate operative revisions owing to further pain, muscle spasm, and even re-ankylosis. The decision when to operate, therefore, requires very careful judgment, and in this respect it is important to determine whether

- (1) Adequate joint function has been lost owing to complete or partial ankylosis and cannot be restored by physio-therapeutic or non-operative measures
- (2) The activity of the disease is on the decline or even has terminated (this is shown by improvement in the general condition of the patient with return of the temperature and pulse rate to normal, relief of pain and muscle spasm, and falling of the sedimentation rate)
- (3) The patient is willing to co-operate whole-heartedly in the intensive and prolonged post-operative exercise regime, and whether the surgeon is available to supervise this extremely important phase of treatment
- (4) Revisions of certain operations may be necessary to obtain a satisfactory end-result
- (5) Anaemia has been successfully controlled by medication or even by repeated transfusion





## CHAPTER 2

### CORRECTION OF THE SPINAL DEFORMITY BY OSTEOTOMY OF THE SPINE

THE ANNOUNCEMENT of osteotomy of the spine for correction of flexion deformity in rheumatoid arthritis was first made by Smith Petersen in June, 1944, and subsequently published in January, 1945

In October, 1946, La Chapelle of Amsterdam also described an operation of osteotomy of the lumbar spine, consisting of two stages, in the first of which the removal of the laminae of the second lumbar vertebra and of the posterior articulations between the second and third lumbar vertebrae was carried out in the second stage, performed through an anterior approach, the second lumbar intervertebral disc was removed, the necessary corrective angulation of the spine being achieved and bone grafts fixed between the two vertebral bodies (La Chapelle 1946) It is understood that La Chapelle now uses the Smith Petersen one stage technique

In October, 1947, Briggs Keats and Schlesinger of New Jersey described an operation of wedge osteotomy of the spine with bilateral intervertebral foraminotomy This is a variant of the Smith Petersen operation, wedge resection of the spinous processes, laminae, articular processes and pedicles of adjacent vertebrae being carried out and the correction achieved by controlled extension of the spine which is usually accompanied by an audible snap as the anterior longitudinal ligament ruptures Briggs Keats and Schlesinger use the Wilson type of spine plate as a means of internal fixation to ensure subsequent fusion of the spine They assert that, unless the anterior longitudinal ligament ruptures correction cannot be maintained without internal fixation

The author's personal experience and follow up of Smith Petersen's cases suggest that sound fusion can readily be obtained in these cases of ankylosing spondylitis by rawing the adjacent laminar surfaces and packing with cancellous bone chips from the removed spinous processes, but following operation the back must be supported, initially in plaster until there is sound bone consolidation, and then in a light spinal brace, until the power of the long spinal muscles has been restored

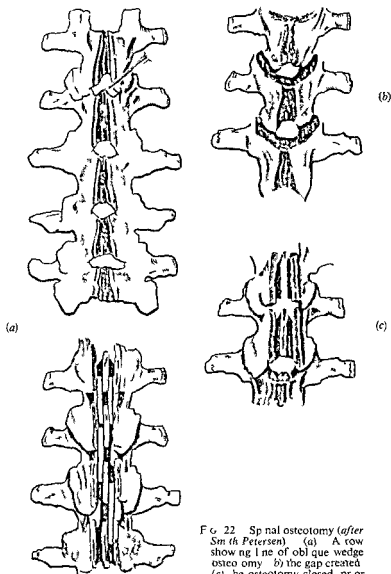


FIG. 22 Spinal osteotomy (after Smith-Petersen). (a) A row showing line of oblique wedge osteotomy. (b) the gap created. (c) the osteotomy closed prior to raising bone flaps for fusion.

The operation of spinal osteotomy aims at producing a compensatory lumbar lordosis for a severe rigid dorsal kyphosis, and may be combined with bilateral arthroplasty of the hips in order to obtain improvement of posture and function. In one case at the Massachusetts General Hospital, Boston, both lumbar and dorsal osteotomies were performed, but Smith-Petersen is of the opinion that nothing was gained by the dorsal osteotomy, though the patient believes to the contrary. The narrow spinal canal in the dorsal region and the rigid thoracic cage not only make dorsal osteotomy a dangerous operation but render it extremely difficult to obtain much extension or correction of the deformity.

### 1 TECHNIQUE

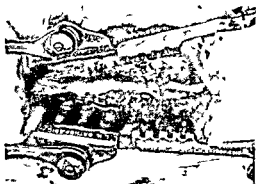
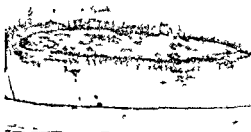
The operation, therefore, is performed in the lumbar region at levels showing a minimum of bony wedging, the excess bone formed in the interlaminar ligaments being excised together with wedges from the intra-articular facets in one or two stages at one, two, or more levels (Fig. 22).

The usual spinal exploration approach is used with the patient in the prone position (Fig. 23 (a)), great care being taken to maintain an efficient airway for respiration and anaesthesia. The spinal muscles are stripped subperiosteally outwards (Fig. 23 (b) and (c)) as far as the line of the articular facets, and the spinous processes above and below the level chosen for the osteotomy site are resected (Fig. 23 (d)) and used subsequently to make cancellous bone chips. After detaching the ligamenta flava, or carefully resecting the bony mass which has replaced these ligaments, a periosteal elevator is passed anterior to the lamina and articular process into the lateral intervertebral notch. The osteotomy is performed (Fig. 23 (e) and (f)) through the superior articular process of the vertebra below and the inferior articular process of the vertebra above, in an oblique plane of 45 degrees with the frontal plane. The number of levels is determined by the extent of new bone formation in relation to the facets and intervertebral discs. Correction is then obtained by hyperextending the spine (Fig. 23 (g)) by breaking the operating table so that the edge of the lamina above slides on to a shelf of the lamina below, without compressing the spinal cord or overstretching the soft tissues, particularly the femoral nerves and vessels (Fig. 23 (i)). The anterior longitudinal ligament is ruptured by the hyperextension. After satisfactory correction, spinal fusion (Fig. 23 (h)) is carried out by raising bone flaps from the laminae and using lamellae from the spinous process which were removed earlier.



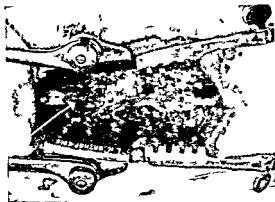
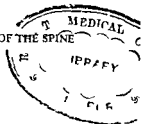
(a) Position of the patient on the operating table

(b) Incision over the lumbar spinous processes

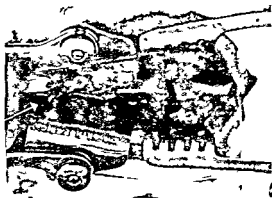


(c) The muscles stripped laterally by subperiosteal dissection

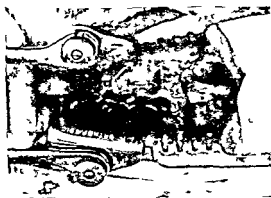
FIG 23 —Spinal osteotomy



(d) The spinous process resected by bone cutting forceps



(e) The oblique osteotomy completed on one side



(f) The osteotomy completed on the two sides

FIG 23 —Spinal osteotomy (cont)



(g) The osteotomy closed by hyperextension producing a lumbar lordosis



(h) Spinal fusion by packing with cancellous bone chips



(i) The correction obtained seen after closure of the wound

FIG 23—Spinal osteotomy (con.)

## 2 POST-OPERATIVE TREATMENT

After the operation the patient is held in the corrected position in a carefully padded and moulded plaster jacket incorporating one or both thighs or nursed in anterior and posterior plaster shells in bed for about 6 weeks. Fusion usually occurs very readily and after this time in bed the patient is allowed to become ambulant in a well fitting plaster jacket which is maintained until there is clinical and radiological evidence of sound fusion.

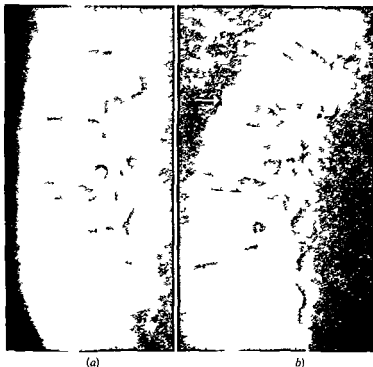


FIG 24—Skiagrams of lumbar spine (a) pre-operative and (b) post-operative appearances

Following this it is preferable to use some form of light spinal support for the next year while the spinal muscles are being re-strengthened and this also tends to prevent further slumping of the spine above the site of the osteotomy during this period.

## 3 RESULTS

Results of this operation are dramatic (Figs 24-27)—one patient stated that he could see ahead for the first time in 18 years but

it is a difficult operation, the spinal extension having to be carefully controlled. Later follow up shows that these patients retain their improved position and are even able to discard their spinal support.

#### 4. COMPLICATIONS

##### Shock

There may be considerable loss of blood during the operation associated with the wide resection of bone and this is best counteracted by blood transfusion at the time of operation. Prior to operation a haemoglobin level as near as possible to 100 per cent is desirable.

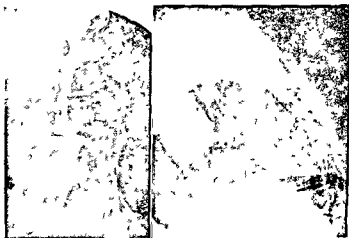


FIG. 25 —Pre operative radiographs of lumbar and dorsal spine showing rigid kyphotic deformity.

##### Respiratory complications

Respiratory complications include some initial mechanical difficulty owing to the lack of chest expansion and to plaster immobilization, which may tend to limit abdominal breathing. For this reason nursing in the prone position during the immediate post-operative period may be dangerous. If necessary, the front of the plaster jacket may be cut out without interfering with the firm hold on the pelvis and chest wall.

Post-operative bronchitis and broncho pneumonia are likely dangers owing to the rigid thoracic cage and are best prevented



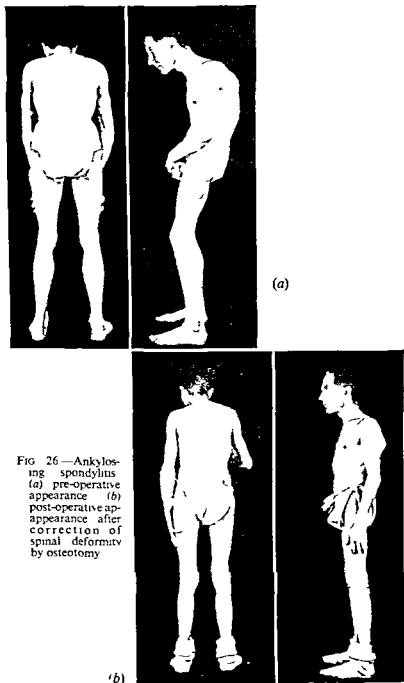


FIG 26—Ankylosing spondylitis  
(a) pre-operative appearance  
(b) post-operative appearance after correction of spinal deformity by osteotomy

### Spinal cord injury

Great care must be taken not to injure the spinal cord or nerve roots by direct trauma while performing the osteotomy or in the course of hyperextending the lumbar spine to create the compensatory lordosis. Perithecal oedema or haemorrhage may result in transient lower limb weakness in the earlier post-operative period, and this should be treated along physiotherapeutic lines, supplemented, if necessary, by splintage for drop-foot, particularly during the night.

### Recurring deformity

Recurring deformity or continued slumping of the dorsal kyphosis may result from too early removal of the spinal support and from lack of attention to the spinal musculature. On the other hand, it may be necessary to obtain the desired degree of correction in more than one stage. Over-correction is to be avoided, as such activities as writing or performing other forms of clerical or sedentary work as well as eating will be interfered with.

### Mortality

The author has lost one patient who died 12 hours after operation for no apparent reason, and who up to the time of the catastrophe had been extremely well. Exhaustive post-mortem examination yielded no further information, and excluded a rare cause of death in these spinal exploration operations, namely, spreading intrathecal haemorrhage. The cause of death in this one case was put down to post-operative shock in a somewhat cachectic individual whose lungs were extensively bronchiectatic. As this occurred shortly after he had been turned into the prone position it is probable that there had been mechanical interference with respiration, and, therefore, it was recommended that nursing in the supine position be carried out for the first 48–72 hours. Opening the theca at operation is usually avoided and if it occurs the escape of cerebrospinal fluid tends to obscure the field of the operation. Such perforations should be closed and it is possible that this injury increases the likelihood of intrathecal haemorrhage.

### Neuritis

A case has not been seen in which there have been vascular complications in the lower limbs from over-stretching of the iliac vessels, but transient femoral nerve neuritis has been known to

## CORRECTION OF THE SPINAL DEFORMITY BY OSTEOTOMY OF THE SPINE

occur with pain and paraesthesiae over the anterior aspect of the thigh and leg. Recovery has followed spontaneously in 2 or 3 weeks.

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## CHAPTER 3

# HIP JOINT RECONSTRUCTION BY VITALLIUM MOULD ARTHROPLASTY

### 1 INTRODUCTION

IN 1939 Smith-Petersen announced his technique of performing arthroplasty of the hip, his aim being to "create all the elements that make up a joint—joint surfaces, surface covering and joint capsule" The inert mould enables organization of the surrounding blood clot to form a joint capsule after congruous joint surfaces have been fashioned Prior to the use of vitallium in 1938, glass, viscaloid, Pyrex and Bakelite had been employed, experimental work extending as far back as 1923, and it was shown, both by joint exploration and by histological examination, that the newly formed joint surfaces consisted of fibro-cartilage, with areas resembling hyaline cartilage, covered by a true synovial membrane which lined the new fibrous tissue capsule and contained synovial fluid

Originally, a two-stage procedure was the intention, but the inertness of vitallium has made the second stage of mould removal unnecessary, the mould becoming a "permanent insurmountable barrier to recurring ankylosis" This clearly is an important advance on such materials as Baer's membrane or pig's bladder, and fascia lata, with which there was a high incidence of recurring ankylosis, as well as further absorption of the femoral head and neck Any hip-joint reconstruction must aim at producing a joint which is painless, stable, and capable of bearing weight This form of arthroplasty aims also at the restoration of a satisfactory range of movement, and thereby of good function with return of muscle power

### 2 THE OPERATION

The hip joint is exposed by the Smith-Petersen approach, using an incision which extends along the anterior third of the iliac crest, downward and slightly medially along the lateral border of the sartorius muscle, with the tensor fascia femoris lying laterally (Fig 28 (a)) On incising the deep fascia the direct head of the rectus femoris is exposed on a deeper plane, and its attachment to the anterior inferior spine is defined

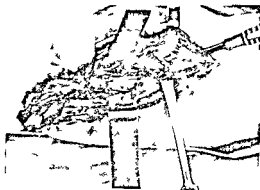
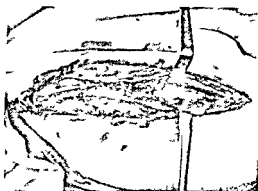
After defining the sulcus between the abdominal oblique and the sartorius medially and the tensor fascia laterally, the periosteum is reflected from the anterior iliac crest and anterior superior spine, and the iliacus is reflected subperiosteally, defining the main portion of the muscle and its marginal origin (Fig 28 (b)). The rectus femoris tendon is divided at the anterior inferior spine and reflected from the anterior capsule, and for further exposure the tensor fascia and gluteus medius are reflected from the lateral aspect of the ilium subperiosteally as far as the anterior margin of the gluteus minimus, and then extraperiosteally owing to numerous large nutrient vessels. The latter part of the dissection may be deleted in the modified Colonna procedure in order to aid more rapid return of muscular power after operation. The rectus femoris muscle is not dissected out of its sheath but both straight and reflected heads are turned downwards and laterally, after the motor fibres enclosed in a fatty compartment have been defined running downwards and laterally from the main trunk of the femoral nerve, and thereby protected from injury which may result from division, contusion or over stretching (Fig 28 (c)). These motor fibres delineate the lower end of the wound.

After the capsular or posterior branch of the lateral femoral circumflex artery has been secured, the anterior capsule is reflected with the rectus muscle or excised, together with the Y ligament of Bigelow and the marginal origin of iliacus, exposing the joint (Fig 28 (d) and (e)), and the osteotomy of the acetabulum and femoral head is commenced at the anterior inferior iliac spine, using osteotomes and special hip gouges. Hypertrophic bone removal at this stage facilitates dislocation of the hip later, and by means of special hip gouges (Fig 28 (f)), which are shaped to the femoral head, excess bone from the acetabulum is removed, the final exact shaping of the acetabulum and femoral head being carried out by special reamers (Fig 28 (h) and (i)) after the joint has been dislocated by adduction and external rotation of the limb (Fig 28 (g)). The acetabulum is deepened to the inner cortical wall of the pelvis, care being taken to avoid any spur or ridge posteriorly. The femoral head may be drilled if further revascularization is necessary, and a vertical osteotomy of the ilium wedged open with cancellous chips is a useful method of deepening the acetabulum in cases in which instability may occur. The congruous surfaces are obtained by reaming with the femoral head and acetabulum in correct anatomical relationship, particularly in positions of extension, flexion, abduction and internal rotation.



(a) Incision along the anterior third of the iliac crest and extending downward from the anterior superior spine for 6-8 inches between the outer edge of the sartorius and inner margin of tensor fascia femoris

(b) The iliac crest is exposed above and by retracting the sartorius and the tensor medially and laterally respectively the rectus muscle is displayed within its sheath



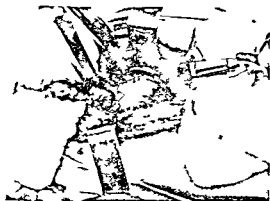
(c) The motor branch of the femoral nerve is demonstrated and the muscles are freed subperiosteally on the inner and outer aspects of the ilium

FIG. 28—Arthroplasty of the hip



(d) The rectus femoris is detached from the anterior inferior iliac spine and retracted laterally and the iliopectus is retracted medially to expose the whole of the superior anterior and inferior capsule and the stem of the Y ligament

(e) The capsule and synovial membrane are excised anteriorly and the joint is fully displayed



(f) The osteotomy of the acetabulum with the hip gouges in position

FIG 78 —Arthroplasty of the hip (cont)



(g) The femoral head is dislocated from the acetabulum after completion of the osteotomy

(h) Reshaping of the acetabulum and femoral head by gouging and osteotomizing to the level of healthy cancellous bone



(i) The acetabulum and femoral head are made smooth and exactly congruous by means of reamers

FIG 28 Arthroplasty of the hip (cont)



# HIP JOINT RECONSTRUCTION BY VITALLIUM MOULD ARTHROPLASTY



(j) The vitallium mould in place and portion of the anterior iliac crest removed

(k) The stump of the rectus tendon sutured to the anterior border of the gluteus minimus and to the lateral margin of the iliacus closing the joint completely



(l) Suture of the muscular layer

(m) The wound after suturing the skin



FIG 28 —Arthroplasty of the hip (cont)

After the mould has been placed (Fig 28 (j)), allowing free movement between itself and the femoral head and the acetabulum, and yet remaining stable, closure is rapidly effected by suturing the rectus tendon to its reflected head and to the anterior border of the gluteus minimus and ilio-psoas (Fig 28 (k)), and by suturing the iliac crest periosteum to the lateral iliac crest musculature (Fig 28 (l) and (m)).

During the operation blood loss is counteracted by blood transfusion, 1–3 pints as necessary, and particular attention must be paid to this during the osteotomy and reaming procedures. Smith-Petersen is of the firm opinion that any operative shock is due to blood loss and not to "pounding" of the bone. Diathermy and suction are valuable aids, and it also must be stressed that the correct hip gouges and reamers are essential for this operation.

In cases of ankylosing spondylitis in which solid bony ankylosis is common, the cleft between femoral head and acetabulum has to be made by the use of osteotomes and by the special hip gouges, the final re-shaping of the new acetabulum and femoral head being carried out after dislocation has been achieved. The dislocation should be performed gently, and provided that the osteotomy is complete, it is a simple manoeuvre of adduction and external rotation of the limb. Force should not be used, because it is quite easy to fracture the femur in the subtrochanteric region. The adduction and external rotation of the hip is less easy to perform when the knee joints are also ankylosed, but even when knee flexion can be carried out care must be taken not to over-strain the joint capsule, this causes troublesome pain and swelling, as well as subsequent weakness in the knee joint and requires intensive treatment and even delays final weight-bearing.

### 3 POST-OPERATIVE REGIME

The limb is suspended in a Hodgen splint with a Pearson's knee attachment and about 5 pounds skin traction for 4 weeks (Fig 29). During this time attention is paid to rehabilitation of the musculature, and hip movement is also encouraged by the patient sitting up and lying down flat, in alternate periods, for flexion and extension, together with knee flexion exercises (Fig 30). At the end of the fourth week the traction is removed and roller-skate exercises are commenced for the abductor and adductor musculature. The skates are strapped on to the posterior aspect of the patient's ankles, and movement is carried out on a hinged platform, which can be inclined to increase resistance as the exercises

HIP JOINT RECONSTRUCTION BY VITALLIUM MOULD ARTHROPLASTY  
progress (Fig 31) Exercises are also carried out in the prone  
position in order to encourage extension of the hip (Fig 32)

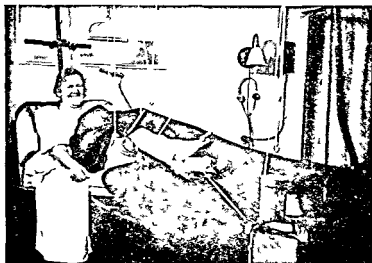


FIG 29 —Arthroplasty of the hip Post operative regime Light skin traction in balanced suspension The limb is abducted and internally rotated



FIG 30 —Post operative regime Knee and hip flexion

At the sixth week the patient is allowed up in a chair and progresses to exercise on a stationary bicycle the seat of which is adjusted for movement in flexion and extension Walking may be re established best by using a walking machine prior to crutches

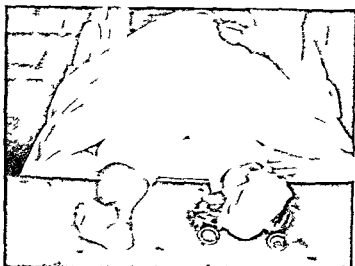
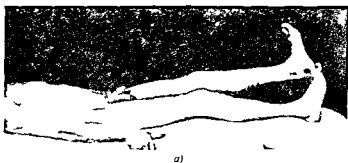


FIG 31—Post-operative figure Role ka ng on h ng d boad



a)



(b)

FIG 3 —Post-operative figure a and b a gh leg a ngexe se

HIP JOINT RECONSTRUCTION BY VITALLIUM MOULD ARTHROPLASTY  
and by encouraging a goose step type of gait initially Crutches  
are maintained for as long as 6 months and during this time  
exercises are continued on the bicycle climbing stairs (Fig 33)



FIG 33 —Post operative regime Stair-climbing exercise

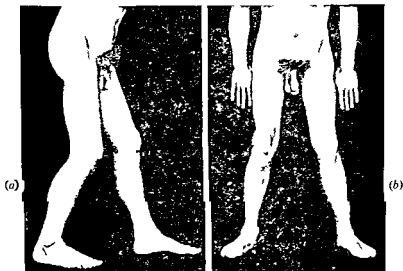


FIG 34 —Post-operative function (a) forward jumping and (b) side ways jumping

and by sideways and forwards jumping (Fig. 34). Gait is improved and loss of a Trendelenburg dip or lurch is achieved by paying considerable attention to the abductor muscles and walking sticks replace the crutches as the patient's muscle power and stability improve. The importance of keeping a correct heel and toe action with the hip pushed inwards towards the centre of gravity must be impressed upon the patient. Regular supervision is maintained for a period of at least 2 years and the active co-operation of the patient in the regime is an important factor in obtaining a good functional result.

#### 4 MODIFIED ARTHROPLASTY

The routine arthroplasty is modified under certain conditions so that 4 procedures may be described all incorporating the use of a vitallium mould and the re-shaping of congruous joint surfaces.

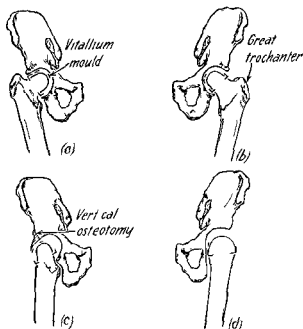


FIG. 35. Types of arthroplasty. (a) Routine arthroplasty. (b) modified Whistman. (c) modified Colonna. (d) proximal shaft or intertrochanteric arthroplasty.

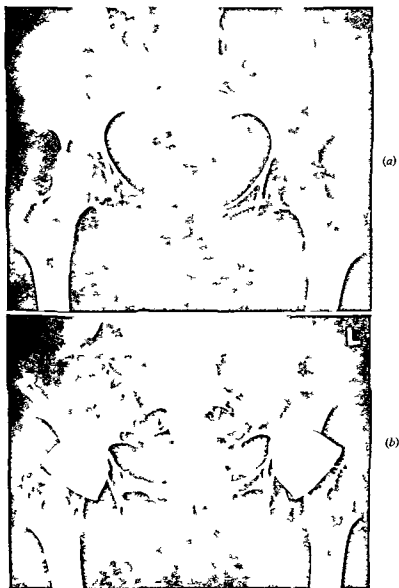


FIG. 36 Radiographs showing (a) pre-operative appearance and (b) post-operative appearance (after 6 months)

**Routine mould arthroplasty**

Routine mould arthroplasty can be carried out when there is sufficient healthy bone in the femoral head and neck the new acetabulum and femoral head being made smooth and exactly congruous by means of the special reamers and the vitallium mould fitted so as to be freely movable on the femoral head and



FIG. 37. B late al re onstruct on of h p joints by rout ne type of v tall um mould arthroplasty afte 21 months

in the acetabulum (Figs 35, 36 and 37). This is by far the most common type of reconstruction carried out in cases of ankylosing spondylitis at the present time.

**Modified Whitman procedure**

The modified Whitman procedure is indicated in cases in which the bone constituting the femoral head is too atrophic, avascular or cystic to allow adequate re-shaping. The femoral head is sacrificed and the mould fitted over the femoral neck which has been made smooth and congruous with the acetabulum (Fig. 35 (b)). The greater trochanter with its attached muscles is detached and refixed distally on the femoral shaft in order to lengthen the



femoral neck and place the important abductor muscles at a better mechanical advantage

### Modified Colonna procedure

If the bone of a considerable portion of the femoral neck is unsuitable for re-shaping, the muscles are detached from the greater trochanter and transposed downwards on the femoral shaft. The greater trochanter itself is re-shaped and made congruous with the new acetabulum, if possible obtaining some degree of a varus relationship to improve stability. The mould is applied over the greater trochanter and, if necessary, the acetabulum can be deepened still further by vertical osteotomy and by wedging its margin outwards (Fig 35 (c))

### Inter-trochanteric or proximal shaft arthroplasty

The complete femoral head and neck are sacrificed in this procedure, both greater and lesser trochanters being transposed downwards together with the tendon of insertion of the ilio-psoas muscle, and a new articulation formed between the proximal portion of the femoral shaft and the acetabulum, together with the insertion of a vitallium mould (Fig 35 (d)).

### Practical observations

Vertical osteotomy of the ilium at the margin of the acetabulum, followed by wedging the surfaces apart and packing the gap created with cancellous bone chips from the iliac crest, is very effective in deepening the roof of the acetabulum a further  $\frac{1}{2}$ – $\frac{3}{4}$  inch, thereby improving the stability of the mould. This is of particular value in the modified Colonna and inter-trochanteric arthroplasties, and in cases of ankylosing spondylitis in which there is such a tendency to re-ankylosis, the wider resection of bone that these operations entail may be beneficial as regards restoration and maintenance of hip joint movement, without any real loss of stability, though residual muscle weakness is more difficult to overcome (Figs 38 and 39). These operations also result in a greater loss of leg length than is the case in the routine arthroplasty procedure, but in bilateral cases this obviously is of less significance. By the amount of bone resected the proximal shaft arthroplasty can be likened to the Girdlestone and Batchelor-Stamm operations, except that congruous joint surfaces are fashioned and a vitallium mould inserted. In the Girdlestone

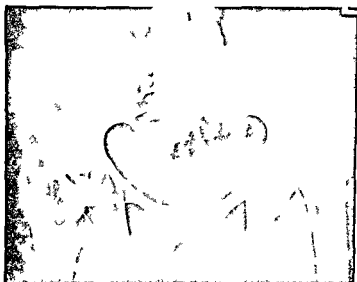


FIG 38 —A case of ankylosing spondylitis treated by excision of the femoral head and neck on the left side



FIG 39 —A modified Colonna reconstruction on the right side. The preserved stability and equal length but the complete loss of movement than on the left

operation the head and neck of the femur are completely excised, and Batchelor and Stamm supplement this with an osteotomy which aims at improving stability. However, it would appear that in these pseudoarthroses mobility is obtained at the cost of some stability, and the patients may have to wear walking caliper splints temporarily or even permanently.

When hip-joint reconstruction is being performed for bilateral hip disease the second arthroplasty may be carried out 2-4 weeks after the first, and the subsequent rehabilitation is adjusted accordingly. Before the second operation it is essential to ensure that the patient's general condition, and in particular the haemoglobin level, are satisfactory, and this is also more important if these two operations have to be followed by osteotomy of the spine or by operations on other joints.

## 5 POST-OPERATIVE COMPLICATIONS

### Surgical shock

Surgical shock may be prevented by counteracting the blood loss, which may be severe during the gouging and reaming stages of the operation, by blood transfusion. During the operation it is also important to prevent any degree of anoxaemia, particularly if the type of anaesthesia used includes Trilene or Tubarine.

### Injury to the motor branch of the femoral nerve

This injury occurred in one case in spite of identification of the nerve in the early stages of the operation. In this patient there was a severe and long standing flexion deformity of the hip joint, and corrective osteotomy performed 2 years previously had failed to relieve the deformity. It is possible that the nerve was overstretched in the course of releasing the limb from the markedly flexed position. Active muscle contractions returned after 5 months. If the nerve is fully displayed it should not be cut during the operation, but it may be compressed by unduly heavy retraction, though usually this merely produces a transient weakness.

### Displacement of the femoral head

Displacement of the femoral head from the vitallium mould or of the mould from the acetabulum does not occur if the Smith-Petersen technique is accurately followed. In cases in which there is severe bilateral adduction, flexion and internal rotation deformity, after operation on the first hip care must be taken that

this limb is held in abduction and internal rotation, and that the limb on the unoperated side is prevented from going into extreme adduction. This will prevent the danger of subluxation of the arthroplasty during a stage in which the anterior and lateral muscle groups have not yet had time to become firmly re-attached. It may even be advisable to use a short hip spica plaster to fix the pelvis and to prevent adduction until the deformity has been overcome in the second hip joint at the next operation, after which both limbs can be suspended in abduction with ease and comfort.

### **Bone absorption**

Bone absorption within the mould occurs to a slight extent in many of the cases as the mould settles down on the head, but if congruous joint surfaces have been refashioned at the level of healthy bone and the mould does not fit too tightly there will be no excessive degree of bone absorption in the femoral head or acetabulum.

### **New bone formation**

Formation of new bone around the mould is likely to occur if ragged periosteal fringes or raw bone surfaces are left exposed. Such areas should be trimmed and coagulated with diathermy before closure of the wound. There is a strong tendency for these cases of ankylosing spondylitis to undergo re-ankylosis, particularly if the disease is not fully "burnt out", but this is best counteracted by free resection of bone, making the acetabulum large and deep, and by using a large size of mould. If capsular fibrosis or ossification recur together with muscle spasm, giving rise to faulty relationship of the mould and to mechanical interference of hip-joint function, operative revision of the arthroplasty must be carried out. Both femoral head and acetabulum must be re-shaped and the correct size of mould re-fitted. For some of his cases Smith-Petersen has repeated this revision on two or three occasions on each hip joint, and those are among the most satisfactory end-results, though clearly this is an immense surgical programme requiring courage and whole-hearted co-operation on the part of the patient.

### **Contracture**

Contracture or persistent spasm of the adductor groups of muscles may necessitate tenotomy or myotomy, or even obturator neurectomy but as a rule the depth of the new acetabulum allows sufficient inward shift of the limb axis towards the midline to release these muscles.

## Infection

Infection may be superficial involving the overlying soft tissues only or deep with bone and joint involvement also. The relatively devitalized tissues are prone to sepsis which must be prevented by careful aseptic operative technique and by the use of systemic and local penicillin treatment as a protective umbrella. The local administration of penicillin solution by means of cannulae



FIG. 40.—Bilateral arthroplasty of the hip joints with the mould removed on the left side on account of infection which resolved.

inserted into the wound as described by Smith Petersen may avert necessity for more extensive drainage of the joint and removal of the mould (Fig. 40). Septic arthritis is likely to result in reankylosis which can be treated by revision of the arthroplasty at a later date when the infection is absolutely quiescent.

SUMMARY OF CASE RESULTS (10 CASES, 19 ARTHROPLASTIES)  
(These are interim results only)

Average range of movement		Satisfactory		Unsatisfactory	
		Patient	Surgeon	Patient	Surgeon
Flexion	37				
Abduction	15	14	10	5	9
Rotation	10				

This table can be compared with the results announced by Smith Petersen (1939)

## 6 SOME TYPICAL CASE SUMMARIES

Case	Pre-operative findings	Operations	Result
1 F M, male, aged 25	Onset 1939 April, 1947 Completely rigid spine, hips and knees 25° flex- ion adduction and internal rotation deformity of each hip	19 5 47 Arthroplasty of right hip 16 6 47 Arthroplasty of left hip	June, 1948 Walking with sticks and free from pain 15° abduction-adduc- tion, and few degrees are of rotation in each hip Patient finds this satisfactory Surgeon would like greater range of movement, but at the present time he is at least using and re developing muscle groups
2 A C, male, aged 32	Onset 1940 April, 1947 Rigid spine 30° fixed flexion deformity of hips Some mobility in knee joints	5 5 47 Arthroplasty of left hip 2 6 47 Arthroplasty of right hip	July, 1948 Recently has had a "flare" of joint pains in knees, right hip and shoulders Range of hip movements retained Flexion deformity 20° on both sides Flexion 50° Abduction adduction 25° in each hip Rotation 10° Walking with sticks May require osteotomy of spine at a later date Result at present satisfactory to both patient and surgeon
3 W S, male, aged 26	Onset 1947 October, 1946 Rigid spine 35° fixed flexion deformity of both hips	24 10 46 Excision of head and neck of left femur 13 3 47 Arthroplasty (modi- fied Colonna) of right hip Mild wound infection 20 7 47 Excision of adher- ent scar over right iliac crest	July, 1948 Walking well with crutches Leg lengths 1 inch longer on right Carries out straight leg-raising on the right Trendelenburg position on left Movements Flexion right 25° left 45° Abduction- adduction " 10° " 25° Rotation " 40° " 10° Still somewhat unstable on the left

# HIP JOINT RECONSTRUCTION BY VITALLIUM MOULD ARTHROPLASTY

Case	Pre-operative findings	Operations	Result
4 S.R., male, aged 26	Onset 1941 April, 1947 Rigid spine Rigid hip joints 60° knee flexion range	7 7 47 28 7 47 Arthroplasty of right hip Arthroplasty of left hip	July, 1948 Free from pain Muscle spasm at extremes of movement only Walking well with 2 sticks Returned to clerical work Flexion deformity right 15° left 10° " range " 50° " 55° Abduction adduction " 15° " 20° Rotation " 5° " 10° Patient and surgeon satisfied at present
5 L.O. female, aged 31	Onset, 1940 October, 1947 Ankylosed hips with flexion adduction internal rotation deformity Scissors gait Stiffness of back and knee joints	15 12 47 29 12 47 Arthroplasty of left hip Arthroplasty of right hip	July, 1948 Minimal pain Walks well with walking sticks and able to carry out straight leg raising Bicycles and climbs stairs Flexion range 40° on each side Abduction adduction 10° " " Rotation 10° " " Result at present satisfactory to both patient and surgeon
6 E.M. female, aged 32	Onset, 1938 Pain and stiffness in back and left hip with gradual progress to rigid lumbar and dorsal spine, unsoundly ankylosed hip joints in 30° flexion deformity	10 7 47 11 8 47 4 9 47 Osteotomy of spine Arthroplasty of left hip Arthroplasty of right hip	July 1948 Holds herself erect and walks well with sticks Some pain and hamstring spasm on the right side Spine soundly fused in corrected posi- tion Hip movement Flexion 55° on each side Abduction adduction 30° " " Rotation 15° " " Result satisfactory to patient and surgeon

# ANKYLOSING SPONDYLITIS—PART II

Case	Pre-operative findings	Operations	Result
7 W J W, male, aged 32	Onset 1942 October, 1947 Rigid spine and completely ankylosed left hip in 40° flexion Right hip painful and stiff also	29 3 48 Arthroplasty of left hip 12 4 48 Arthroplasty of right hip	June, 1948 A subtrochanteric fracture of the right femur was incurred whilst manipulating the hip September, 1948 Soundly healed Free from pain in both hips Walking well with crutches Bicycles and climbs stairs Hip movements Flexion left 25° right 30° Abduction adduction " 15° " 15° Rotation, a few degrees on each side This case is not classed as satisfactory
8 C M male aged 37	Onset 1935 Left artificial pneumothorax for pulmonary tuberculosis, followed by progressive pain and stiffness in the low back and hip joints January 1948 Complete bony ankylosis of both hips in 45° flexion deformity	April August 1945 Bilateral subtrochanteric, osteotomies — elsewhere 9 2 48 1 3 48 Arthroplasty of right hip Arthroplasty of left hip 10 6 48 Excision of sinus and removal of mould on left In- sertion of strep- tomycin and peni- cillin cannulae	September, 1948 Temporary paralysis of left quadriceps with recovery in 4 months after operation Wound infection on left with sinus developing down to the hip joint, apparently within the mould Culture Haemolytic streptococci Staphylococcus pyogenes and Bacillus coli No tubercle bacilli Healed after revision Walking with crutches Hip movements Flexion right 85° left 45° Abduction adduction 40° , 25° Rotation 40° , 20° A satisfactory result



# HIP JOINT RECONSTRUCTION BY VITALLIUM MOULD ARTHROPLASTY

Case	Pre-operative findings	Operations	Result
9 D M. female, aged 23	Onset 1945 Bony ankylosis of hips and lumbar spine	5 6 48 Arthroplasty of right hip 3 7 48 Arthroplasty of left hip	August, 1948 Tendency for the femoral head to dislocate from the mould on the left side Controlled by abduction and internal rotation Result at present not determined
10 J A. male, aged 39	Onset 1937 Initially diagnosed as tuber- culosis of the spine—dorsal 12 and lumbar 1 1944 Pain and stiffness in right shoulder, hips and knee joints 1946 Ankylosing spondylitis established	28 2 48 Arthroplasty of right hip, subtro- chanteric fracture incurred 17 4 48 Arthroplasty of left hip, stainless steel mould	August, 1948 10 of movement in each hip only, but is able to walk with crutches and to continue muscular re- development Will require revisions at a later date An unsatisfactory result
11 J D. male, aged 21	Onset 1942 Bony ankylosis of hips and knees Sedimentation rate still raised slightly	20 12 47 Arthroplasty of left hip 17 1 48 Arthroplasty of right hip, stainless steel mould 3 4 48 Manipulation of hip joints under anaes- thesia 3 7 47 Manipulation	August, 1948 Slow progress, further complicated by a severe "flare" after manipulation of the hips, which showed a free range of movement initially, but this could not be main- tained Will require revision at a later date An unsatisfactory result

## ANKYLOSING SPONDYLITIS—PART II

## 7 FOLLOW UP STUDY

## RANGE OF MOVEMENT AND ESTIMATION OF VALUE OF OPERATION

Years after operation	Average flexion range (degrees)	Condition of Hip			
		Satisfactory		Unsatisfactory	
		Patient	Surgeon	Patient	Surgeon
0-2	44	26	23	4	7
2-3	47	2	1		1
3-4	62	5	5		
4-5	43	2	1		1
Over 5	88	3	3		

## REFERENCES

Smith Petersen M N (1939) *J Bone Jt Surg* 21 269

## CHAPTER 4

### SURGICAL TREATMENT OF JOINTS LESS FREQUENTLY INVOLVED IN ANKYLOSING SPONDYLITIS

#### 1 ANKYLOSIS OF THE TEMPORO-MANDIBULAR JOINT

IN ONE group of cases of ankylosing spondylitis there occurs a solid bony ankylosis literally from head to foot, including involvement of the jaws, the patient finding speech and eating increasingly difficult. This may progress to such an extent that life is endangered, feeding having to be carried out by a nasal tube or by an oral tube introduced through a gap created by extracting a tooth. Frequently in these cases a long programme of reconstructural surgery is indicated, initiated by mobilization of the temporo-mandibular joints to enable the mouth to be opened for the purpose of improving respiration and administration of anaesthesia, in addition to rendering the patient more comfortable and able to build himself up on solid and more nourishing food. Bony ankylosis makes the operation of excision of the condyles of the mandible a difficult one. Extreme care must be taken to avoid damage to the facial nerve or its branches, which pass in front of the joint, and to the superficial temporal artery which lies posteriorly. The use of gouges and osteotomes is limited owing to the danger of fracturing the bone into the middle ear.

#### The operation

The incision used is a curved one extending from the middle of the zygoma downward and backward in front of the tragus, turning the skin flap upwards. By careful dissection the neck of the mandible is exposed and divided by a Gigli saw passed around it, or by bone nibbling forceps. The region of the ankylosis has also to be resected by bone-cutting forceps and sufficient bone is removed with the condyle to leave a gap of about  $\frac{1}{2}$  inch extent. To avoid the prevention of re-ankylosis, a piece of fascia lata, muscle graft, or Cellophane may be inserted between the raw bone surfaces or a flap is taken from the temporalis muscle. The wound is closed by skin sutures only.

The operation is performed on the second side 1-2 weeks later and after this, during the immediate post operative period, close watch must be kept to prevent the lower jaw from receding with

aspiration of the tongue during sleep. In one such case a temporary tracheotomy was required until the muscles had redeveloped sufficient power and control, and until a certain degree of stability had been obtained by surrounding fibrosis.

At a later stage, if movement is being lost, manipulation under anaesthesia is indicated, but a great deal depends upon the patient's own determination and co-operation in carrying out exercises for restoration of jaw movements.

### Esmarch's operation

As an alternative to the above procedure, Esmarch's operation may prove of value. Through an incision behind and below the angle of the jaw, a wedge of bone with its base downwards is resected from the region of the angle of the mandible, and part of the masseter muscle is turned in between the two raw bone surfaces.

Thus operation gives better results than does removal of the vertical ramus of the mandible, after which there is considerable instability and muscle weakness.

## 2 THE SHOULDER JOINT

Adduction internal rotation deformity of the shoulders, with partial or complete ankylosis, occurs in certain cases of ankylosing spondylitis, particularly in association with involvement of the cervical and upper dorsal spine. This distribution of the disease was formerly termed von Bechterew's arthritis, as opposed to Marie-Strumpell arthritis, the latter involves the sacro-iliac joints, lumbar spine and hip joints in solid bony ankylosis.

During the active and painful phase of the disease, immobilization should be carried out with the shoulder in the position of optimal function should ankylosis occur, that is, 50–60 degrees of abduction, 20–30 degrees anterior to the frontal plane, and about 20–30 degrees of external rotation. The same position is aimed at in formal arthrodesis of the shoulder, which is indicated for the relief of pain and deformity with loss of function.

This operation should only be performed if the muscles controlling the scapula are intact and can be made powerful enough to carry the fused shoulder girdle and upper arm through an adequate range of movements. Care must be taken to avoid fusing the humerus and glenoid in excessive abduction, which would prevent the patient from swinging the arm to the side.

### The operation

The shoulder joint is exposed by the anterior approach, using a skin incision extending downwards in the delto pectoral groove from the coracoid process for 6-8 inches. If necessary the incision can be carried upwards in a "sabre" manner towards the acromion process, allowing a more extensive separation and lateral retraction of the deltoid muscle, and the coracoid process with its attached muscles can also be detached by osteotomy and turned medially and downwards. The subscapularis muscle on the front of this capsule is then divided vertically and the joint is entered through an incision in the capsule and synovial membrane.

Articular cartilage is removed from the head of the humerus and from the glenoid cavity of the scapula, raw bone surfaces being shaped to fit exactly with the arm placed in the correct position for maximum function. The under aspect of the acromion process is also osteotomized to provide a raw surface for bony fusion, and the process itself can be turned down and slotted into the upper end of the humerus as a form of extra articular graft. Finally, a short 3 flanged Smith Petersen nail can be inserted from the humeral neck, through the head, into the glenoid to ensure adequate internal fixation. After closure of the wound in layers the limb is immobilized in a plaster cast until there is clinical and radiological evidence of bone consolidation. This usually takes about 3 months, and has to be followed by a period of muscle training and redevelopment to provide adequate function.

The operation rarely has to be carried out for ankylosing spondylitis and it is only indicated in cases in which there is persistent pain and persistent disability, usually the result of faulty treatment in the earlier stages of the disease.

### 3 THE ELBOW JOINT

The elbow joint is even less frequently affected than is the shoulder, but if it is involved bony ankylosis occurs in a position of flexion and approximately mid rotation of the forearm (Fig 41 (a) and (b)). During the early stages the ankylosis may be encouraged by the necessity of immobilization for the relief of pain, and with bilateral involvement the amount of flexion on one side must be less than 90 degrees to allow the hand to reach the mouth and on the other side greater than 90 degrees for the purpose of carrying out such actions as writing and grasping.

**The operations**

Restoration of movement can be achieved at the cost of some stability by carrying out arthroplasty on these ankylosed joints (Fig 41 (c)). The two methods of performing arthroplasty are detailed

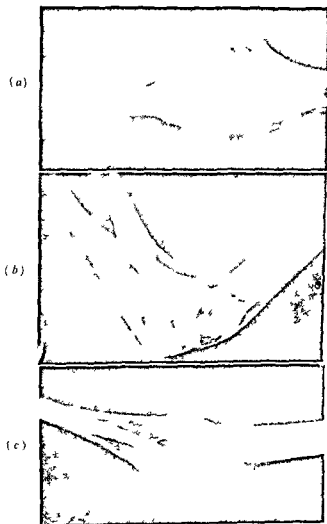


FIG 41—Arthroplasty of the elbow joint (a) and (b) pre operative x ray appearance (c) post operative x ray appearance

Using a midline dorsal approach, stripping muscles subperiosteally laterally and medially and taking care of the ulnar nerve on the medial side, the elbow joint region is exposed from above the olecranon fossa to below the base of the olecranon process. Sufficient bone has to be removed from the lower end of the humerus and from the upper end of the radius and ulna to allow free movement without the joint becoming excessively flail. The humerus is divided transversely by means of a Gigli saw or osteotome just above the olecranon fossa, and distally the head of the radius is removed through the neck and the upper end of the ulna just distal to the coronoid fossa. The resection of bone is equivalent to that of the classical joint excision operation.

The raw bone ends may be covered with fascia lata from the thigh or flaps may be turned in from the triceps expansion, and the midline incision through triceps and skin is then re-sutured.

For the immediate post-operative period a posterior plaster slab is incorporated in the dressing and overhead suspension is used to control oedema and to maintain an adequate space between the new bone ends. After removal of the skin sutures on the tenth to twelfth day, lightweight skin traction is employed over pulleys on the overhead beam together with assisted and active flexion and extension exercises. This is maintained for 2-3 weeks and is followed by the wearing of a collar-and-cuff sling and by continuance of the exercise regime while the patient is ambulatory.

In the second type of elbow arthroplasty operation, after bone resection of the lower end of the humerus, the head of the radius and part of the coronoid fossa of the ulna, the humerus and ulna are re-shaped and made as smooth and congruous as possible. The raw surfaces may be covered with fascia and, after closure of the wound, a similar programme of after treatment is instituted.

For this operation a different form of approach to the joint can be used. This takes the form of a U-skin flap extending to the base of the olecranon process, which is divided transversely and turned upwards with the attached triceps expansion. The bone resection and re-shaping is then carried out, the surfaces being finally made smooth by means of a bone file, and the first stage of the closure consists of replacing the olecranon process which can be held in place by periosteal sutures.

The object of this type of operation is to provide a more stable joint, but, in cases of ankylosing spondylitis as opposed to traumatic or degenerative arthritis, owing to periarthral fibrosis and muscle contracture, instability following joint excision is much less certain. In one case following the second type of arthroplasty

a range of active movement between 70 and 150 degrees flexion-extension was obtained, but following a blow on the joint, with subsequent pain, effusion and muscle spasm, only 20 degrees of movement was retained. The greater bone resection in the first type of operation appears to provide a wider range of movement and a better function in cases of rheumatoid arthritis and ankylosing spondylitis without undue loss of stability or power.

#### 4 THE KNEE JOINT

If the knee joints are involved and correct treatment is instituted in the early stages, it is possible to avoid gross flexion deformity, even though solid ankylosis is likely to be the final result. Traction or plaster immobilization, either in a spica or anterior and posterior shells, will reduce pain and muscle spasm. Undue muscle wasting and loss of power should be controlled by physiotherapeutic measures. By these means, together with x-ray therapy, it may be possible to retain joint movement, but only too frequently the patient does not attend for treatment until the disease has progressed to such an extent that ankylosis is almost inevitable. The problem facing the surgeon at that stage may be, therefore, bilateral stiff hips and knees, rendering the patient immobile. The hip joints can be mobilized as previously described, but the knee joints present a very much more difficult problem.

If solid ankylosis has occurred without more than 15–20 degrees flexion deformity, interference with weight-bearing is minimal, and provided adequate movement at the hip joint can be obtained, sitting and walking become perfectly feasible, but excessive fixed flexion deformity prevents or hinders even a crab-like type of gait aided by crutch support. In these cases reconstructive surgery is indicated, and the means at our disposal are (a) arthrodesis in 10–15 degrees flexion for maximal function and (b) arthroplasty.

Plastic operations on the patella, partial or complete patellectomy, or synovectomy and meniscectomy are of little or no use in cases of ankylosing spondylitis, and arthroplasty of the knee is still a difficult and uncertain procedure. The great difficulty is to retain sufficient stability to make the range of movement worth while, and it appears to be impossible to retain or restore the "screw-lock" action between femur and tibia which is essential for stable weight-bearing.

##### **Arthrodesis of the knee**

Under tourniquet control the joint surfaces are exposed by a para-patellar incision or by a U-shaped skin flap, the patella being



displaced laterally or turned upward after dividing the ligamentum patellae. As an alternative the patella may even be removed. The synovial membrane and menisci are excised together with any remaining articular cartilage on the lower end of the femur, the upper end of the tibia and articular surface of the patella. This is carried out by means of an osteotome or a saw, care being taken of the important vessels and nerves posteriorly, and adjacent femoral and tibial surfaces are fashioned to fit exactly. The coaptation may be reinforced by (a) packing with cancellous bone chips from the iliac crest or femoral shaft, (b) slotting in the patella anteriorly, (c) removing a full thickness graft from the femoral shaft just above the line of the condyles, and driving this into a centrally made bed across the femoral and tibial surfaces from the lower end of the graft site, (d) the insertion of twin grafts or bone pegs in two planes across the line of the arthrodesis, or (e) internal fixation by a short obliquely placed 3 flanged nail, placed across the arthrodesis and extending between the inner tibial cortex below and the outer femoral cortex above.

After closure of the skin the limb is further immobilized in a long plaster extending from groin to toes, or in a hip spica. Fusion is usually readily achieved in ankylosing spondylitis in about 3 months, a walking plaster being used from about the eighth week onward. This plaster is removed only when fusion is clinically and radiologically sound.

### Arthroplasty of the knee

The joint line is exposed in a similar manner to that for arthrodesis of the knee, the patella being resected and the joint is reformed by (a) Resecting sufficient bone from the lower end of the femur and the upper end of the tibia to form a gap wide enough to prevent reankylosis. The raw bone surfaces may be lined with fascia lata or with Cellophane. (b) Femur and tibia are re-shaped in a uni-condylar manner, a bulbar lower end of the femur being made smooth and as congruous as possible with a saucer-like upper end of the tibia. The surfaces, again, may be lined with fascia. (c) The anatomical shapes of the lower end of the femur and upper end of the tibia are re-fashioned with specially shaped gouges, and a vitallium plate with superior and inferior aspects shaped to correspond to the femur and tibia, is inserted between the bone ends. Smith Petersen has attempted to anchor such a plate by means of a 'centre board' flange which is driven into the upper tibia, and Thrapmeyer (in a personal demonstration)

has special apparatus for accurately shaping the bone ends and fitting a vitallium mould

After closure of the wound, the limb is placed on a Thomas splint with light skin or skeletal traction, or Hamilton Russell type of traction is used for 4–6 weeks. An intensive exercise regime is instituted to redevelop quadriceps power and tone upon which the future stability and strength of the joint entirely depend

The results of such operations are not yet satisfactory, it being rare to obtain more than 20–30 degrees of knee flexion without undue loss of stability

### 5 ANKLE AND FOOT DEFORMITIES

It is rare for ankle and foot joints to be directly involved in ankylosing spondylitis, but commonly, as the result of prolonged immobilization in bed, without adequate or skilled nursing supervision or physiotherapeutic control, stiffness and deformity occur in the ankle, tarsal, metatarsal and interphalangeal joints. Ideally, such disability should be prevented by correct splintage, by protection from prolonged pressure of the bed clothes by using an adequate bed cradle, and by active exercise for all these joints carried out as a daily routine. In more advanced cases assisted exercises may be of value in the preliminary stages, and electrical methods such as faradism are helpful in restoring ligament and muscle tone and power

When pain and stiffness are present in the ankle joint, together with some degree of equinus or rotation deformity, weight bearing may be difficult, though equinus in the ankle must always be considered in relation to flexion deformity at the knee joint. For purposes of walking comfortably the foot must be plantigrade, and it must be possible to get the heel to the ground prior to transferring the weight through on to the forefoot. The talus must fit squarely and accurately into the joint mortice formed by the lower end of the tibia and the internal and external malleoli

#### Arthrodesis of the ankle

Arthritic changes with deformity and pain in the ankle joint, which cannot be controlled by conservative measures, must be treated by arthrodesis of the ankle. This provides painless, stable weight bearing, a position of about 15 degrees equinus being adopted to allow for the heel on the footwear, though this must be adjusted to any permanent deformity present in the knee joints

The operation is carried out through an anterior midline or

lateral approach under tourniquet control, the articular cartilage being removed by osteotomes from the adjacent tibial, astragalar and malleolar surfaces, which are also shaped to fit each other as accurately as possible. This may be reinforced in several ways, such as (a) by packing with cancellous bone chips from the iliac crest and tibia, (b) by taking a full thickness graft from the anterior surface of the lower end of the tibia and slotting it into the upper aspect of the astragalus, leaving a bridge of bone at the inferior margin of the tibia to aid holding the graft in place and (c) by using the lower end of the fibula and external malleolus as a lateral onlay graft, after rawing adjacent surfaces on the lateral aspect of the tibia and astragalus and the medial surface of the fibular fragment. This graft is fixed by vitallium or stainless steel screws of sufficient length just to penetrate the inner tibial and astragalar cortex and is supplemented by a screw placed obliquely across the line of fusion and including the onlay graft. This procedure is carried out through the lateral approach, the incision extending down the lower end of the fibula and curving inferiorly around the external malleolus.

After closure of the wound, the foot and ankle are immobilized in an above-knee padded plaster, with the knee slightly flexed, and the tourniquet or pressure cuff removed. In 6-8 weeks the plaster is changed to a walking type of cast, which is maintained until there is clinical and radiological evidence of sound fusion.

During the period of plaster immobilization care must be taken to maintain active toe movements and to avoid incorrect methods of walking.

### Mid-tarsal arthrodesis

Arthritic changes in the mid-tarsal joints, with pain and fixed eversion deformity, may necessitate treatment by triple arthrodesis to enable painless stable weight bearing.

Occasionally a complete pan arthrodesis may be required if there is gross deformity in the ankle and tarsal joints. The sub-astragaloid, calcaneo-cuboid, and astragalo scaphoid joints can be approached through an incision from below the external malleolus towards the base of the third metatarsal. The adjacent cartilaginous surfaces are resected by means of osteotomes, together with any bone wedge for correction of deformity, inversion of the foot being employed to give full exposure of the various joint surfaces. The raw bone surfaces are shaped to fit one another as accurately as possible, and this can be supplemented by packing with cancellous bone chips. After closure of the wound, fixation in a padded

plaster is employed along similar lines to the procedure in ankle-joint fusion

Pain in the forefoot is often associated with dropping of the metatarsal heads, with claw-toe or hammer toe deformity, and, in the case of the great toe, with hallux valgus or hallux rigidus deformity. Arthritic changes in the metatarso-phalangeal joints may be accompanied by subluxation or complete dislocation, and faulty weight bearing results in painful callosities on the plantar aspect of the foot. In mild cases physiotherapeutic measures, aimed at restoring the tone and power of the intrinsic foot muscles, may be of great value, and such treatment must always accompany any operative intervention. The use of specially made footwear, and of Jones metatarsal bars, or metatarsal buttons fitted to insoles, may also help to relieve symptoms in the less severe cases, but when there is fixed deformity surgery is indicated, and the following operations may be employed

- (a) Keller's operation for hallux valgus and hallux rigidus. This operation consists in resection of the base of the proximal phalanx and trimming of the metatarsal head with re-alignment of the toe
- (b) Arthrodesis of the first metatarso-phalangeal joint is an alternative to the Keller operation for hallux valgus and hallux rigidus (in my own experience the Keller operation gives better results)
- (c) Resection of the metatarsal heads or bases of the proximal phalanges for painful subluxation or dislocation at the metatarso-phalangeal joints
- (d) Arthrodesis of the interphalangeal joints for hammer toe deformity. The "spike" operative technique may be employed or, for a more extensive claw-toe deformity, the Lambrinudi operation, fusing all the interphalangeal joints of the toes, and holding the toes in the correct position by means of a special sole splint or by intra-medullary wires
- (e) Amputation of the toes at the metatarso-phalangeal joints, with the object of eradicating painful and grossly deformed digits. Good function can be obtained using specially made footwear



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